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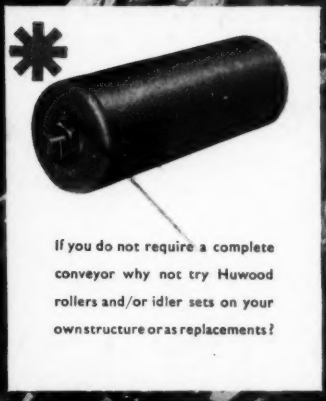

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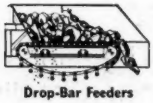
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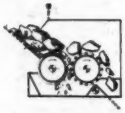
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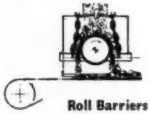
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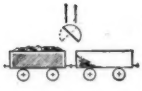
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EDITORIAL

A GIFT of £150,000 to the University of the Witwatersrand by the Gold Producers Committee of the Transvaal and Orange Free State Chamber of Mines was announced last month by the president, Dr. W. J. Busschau. The presentation is "as a tribute to the university's contribution to the progress of the mining industry." Dr. Busschau, it is reported, said that of the 1,200 graduates employed on the Rand 500 had had their training at the University of the Witwatersrand.

AWARDS in the New Year Honours List that will be noted with interest are those of the C.B.E. to Mr. A. J. P. Martin for services in the development of chromatographic analysis and to Mr. H. T. Ramsay, Director of the Safety in Mines Research Establishment of the Ministry of Power. Recipients of the O.B.E. include Mr. P. M. Holman, chairman of Holman Bros., Ltd., of Camborne, and Mr. D. E. Macinnis, Director, Department of Lands, Surveys, and Mines, Territory of Papua and New Guinea.

IN the middle of December detailed plans were announced for a four-year inquiry into the natural resources of Scotland. A committee appointed by the Scottish Council (Development and Industry) is to carry out the work, which aims at "a healthy population through independence and self-help, using internal . . . natural resources augmented by oversea activities." The committee, of which the chairman is Mr. L. A. Elgood, intends to review "land resources, human resources, and fuel and energy."

LAST month the BP Exploration Company gave some information regarding the progress of work in Dorset, where a second test well is being drilled near Kimmeridge. This well, some 2,500 ft. west of Kimmeridge No. 1 well, where a show of oil was encountered at 1,800 ft. in limestone last March, should yield important information. The No. 1 well, it is stated, has undergone a prolonged production test, a production well head having been fitted and two tanks erected for the crude oil. This oil was taken by road tank wagon to Wareham station, where it was transferred to tank cars for carriage to the Pumpherston refinery in Scotland to be processed and tested. The company plans to drill a third and possibly a fourth test well at Kimmeridge. While the original show of oil is considered encouraging much work is still required, it is stated, before it can be known whether it is likely to prove commercial.

British Overseas Mining Association

Speaking at the annual general meeting of the British Overseas Mining Association held on December 21 the president, Mr. A. V. Conrad, after referring to the great importance attached to the acknowledgment of the Overseas Trading Corporation established as a group with special tax status, went on to mention two matters which they would like revised. The Association, in fact, hopes that the Government may be persuaded that Overseas Trading Corporations with non-resident subsidiary companies should be allowed to treat dividends from those companies as exempt trading income, which would make it possible for such earnings to be used to the best economic advantage. Proposals to this effect, the president said, received sympathetic consideration from the Government spokesmen in the debates on the Finance Bills of 1958 and 1959, but they had been rejected on the grounds that their adoption would open a door to tax avoidance. The Association believes that it would be quite practicable to devise safeguards against any such risk and that the extension of the O.T.C. system would be of considerable benefit to the overseas mining industry. In addition it is thought that loans to associated companies should be treated for tax purposes in the same way as distributions to shareholders, while present legislation, which did not overcome the legitimate complaint that United Kingdom taxes often frustrate pioneer and similar tax reliefs, should be amended. These matters, he said, are receiving the careful attention of the Association's Taxation Committee.

JAN 23 1962

The president went on to speak of the work of the B.O.M.A. Educational Trust. At present, he said, 12 students were taking courses at universities or schools of mines and it was expected that further awards to be made in 1960 would bring the total number up to over 20. All candidates for such scholarships were thought to have attained the requisite academic standards and to have the correct qualifications regarding personality, character, powers of leadership, and general aptitude for the overseas mining industry. The Association had every reason to expect that B.O.M.A. scholars, when they ultimately take up positions abroad, will make a valuable contribution to the industry.

The accounts of the Association for the year to September 30 last, embodied in Progress Report No. 15, show that the total membership is now 95. In concluding his address the president acknowledged the work of various committees and expressed the opinion that the views of the industry are now brought vigorously to the attention of the appropriate authorities.

Steel for India

At the end of December the President of India, Dr. Rajendra Prasad, carried out a ceremony bringing into commission the first blast-furnace of the Durgapur steelworks, situated in West Bengal. The ceremony celebrated the inauguration of an integrated steelworks, since e coke ovens are said to be complete as well as the coal washery and by-products plant. While Durgapur is a joint Indian-British effort approximately 50% of the capital expenditure and tonnage of raw materials has been supplied by India and of the 33,000 labour force on the site the vast majority are Indian. In order to provide for the operation of the works 350 Indian technicians, it is stated, are being trained in the United Kingdom through the Colombo Plan, while others are being instructed in Australia, the U.S.A., and elsewhere. In addition the British Iron and Steel Federation have seconded technicians to Hindustan Steel, Ltd., to assist in the initial operation of the works and to complete the training of local operatives.

It is of interest to note that the Durgapur steelworks represents the largest single export contract ever obtained by British industry. The contract, which, when completed, will give Durgapur an initial output of 1,000,000 ingot tons per year (to be expanded later to 2,500,000 tons), is to the value of £105,000,000. It is being carried out for Hindustan Steel, Ltd., by the Indian Steelworks Construction Co., Ltd. (ISCON), a consortium formed specially for the purpose.

Geological Survey of Great Britain

Last month the "Summary of Progress" of the Geological Survey for 1958 became available. The period reviewed is the penultimate year of the quinquennium concluded in March last, a period in which the total area covered by primary survey was 1,721 square miles, which compares with 1,197 square miles in the preceding five years; progress in revision survey was also maintained, the total areas covered being 1,458 and 1,436 square miles, respectively. Here the report emphasizes the desirability of making more rapid progress in both primary and revision survey and it is hoped that this will be made possible by an appropriate increase of staff in the current quinquennium.

The amount of exploratory boring in Great Britain has been a striking feature of the post-war years and the statutory obligations of the Geological Survey under the Petroleum (Production) Acts 1918 and 1934, the Mining Industry Act 1926, the Water Act 1945, and the Water (Scotland) Act 1946, have made very considerable demands upon the time of the staff. During 1958 the number of notifications of intention to sink bore-holes and shafts under these Acts was less than for some years. The footage of strata examined was also less, but even so it exceeded 200,000 ft. Good progress was also made with the comparatively shallow bore-holes which are being drilled in the Cheshire salt-field under the Geological Survey programme of boring; at the close of the year eight of the 15 holes had been completed. They have, it is stated, already given valuable information concerning the nature of the Triassic rocks concealed beneath superficial deposits, the depth to and the thickness of the salt-bearing beds, and one proved barren Coal Measures directly beneath boulder clay. The results should be of great assistance in the construction of the geological maps.

The Survey has continued to use geophysical methods of investigation and bore-hole logging with electrical resistivity equipment in the Chalk has been found useful in

a hydro-geological survey; the airborne magnetic survey in the north of England and the airborne radiometric and magnetic survey in the south-west of England were continued, the latter in association with the United Kingdom Atomic Energy Authority. These surveys were delayed by adverse weather conditions and it was not possible to complete that in the south-west of England during 1958; this survey, note of which has already been taken here, is part of a programme to investigate potential uranium resources in this country. The Survey has continued as geological consultant to the U.K. Authority.

The report of the Atomic Energy Division of the Survey states that as world supplies of uranium and thorium ores are considered adequate for present requirements more attention is being given to fundamental work on the geochemistry, geology, and mineralogy of radioactive ores and to other studies of long-term value. Approval for the five-year reconnaissance programme to establish the possible reserves of uranium in the United Kingdom has, as already noted, been given by the U.K. Atomic Energy Authority and the successful survey of west and central Cornwall in 1958 has been followed by an airborne radiometric survey of the remainder of Cornwall, much of Devon, and part of Somerset. Field investigations overseas have been undertaken in Bechuanaland, Sierra Leone, Ghana, Tanganyika, and Southern Rhodesia. In Cornwall, it is stated, five virgin lodes containing uranium were located as a result of the airborne survey and these have been examined on the ground by pitting, trenching, and exploration drilling. One body containing ore of economic grade has been shown to extend in depth to at least 80 ft. and further drilling is planned to determine the full extent of the mineralization. A number of other occurrences also show promise and are being examined in detail. Cornwall, the report says, has proved to be an excellent testing ground for all types of radiometric equipment and the success of British geological-electronic instruments in other countries of the world stems largely from field experience gained in this country. Investigations in Bechuanaland and Southern Rhodesia were concerned mainly with researches into the application of a new colorimetric method of determining uranium in natural waters developed by the National Chemical Laboratory. Field tests undertaken in Britain have given promising results on most waters with upwards of 1 μg. of uranium per litre. The Division goes on to report that the programme on the determination of the age of uranium, thorium, and lead minerals has progressed steadily, while work in instrumentation has included the development of a device for the optical orientation of crystal fragments prior to X-ray examination, the perfection of a needle counter for the rapid location of radioactive mineral species in rock or ore sections, and experimental work on the use of both photomultiplier tubes and cadmium sulphide cells in the measurement of the reflectivity of very small mineral grains. Considerable assistance in instrumentation has been given to industry in the development of lightweight Geiger-Müller counters as control instruments in the production of uranium ore.

European Coal

The Secretariat of the Economic Commission for Europe has now published its report on "The Coal Situation and Prospects in Europe in 1958–1959." [1] This was a period in which output at last overtook demand and it is suggested that recent studies both international and national are all agreed that, while the demand for energy can be expected to continue increasing with the long-term expansionary trend over the years to come, "it seems clear that the share of coal in the energy market will continue to be a declining one in relative terms, but that the actual level of coal consumption in the coming years will to an increasing extent depend on the competitive position of coal *vis-à-vis* other forms of energy. It is commonly accepted, moreover, that, in line with fluctuations in economic activity, occasional temporary setbacks in demand can be anticipated."

Sharp falls in demand led to the piling up of stocks at pithead in 1949–50 and again in 1953–54. On both these occasions consumers, in the knowledge that supplies were ample, ran down their own stocks, "thus making the situation even more difficult for the coal producers, who in Belgium and in France had to reduce their output, cease recruiting manpower, and introduce short-term working." Both occasions were followed by periods of renewed economic growth with a consequent accrued demand for energy and particularly of coal.

[1] Geneva: European Office of the United Nations. Price 1s. 9d.

MONTHLY REVIEW

Introduction.—Over the past month, with heavy industry continuing its regained momentum, business confidence has remained buoyant. In the circumstances commodity prices, including those of metals, have remained firm, particularly in the light of more settled conditions in the United States.

Transvaal.—The gold return figures for the Rand and O.F.S. mines for November show a production of 1,688,379 oz., making with 34,903 oz. from outside mines a total of 1,723,282 oz. for the month. The number of natives at work in the gold mines at the end of November was 358,746, as compared with 365,833 at October 31 last.

The table below shows dividends declared by the Rand mining companies for the past half-year. Figures for the three preceding half-years are added for comparison, the denominations of shares being £1 unless otherwise stated.

	1st half, 1958	2nd half, 1958	1st half, 1959	2nd half, 1959
	s. d.	s. d.	s. d.	s. d.
Blyvooruitzicht (2s. 6d.)	1 0	1 0	1 1	1 2
Brakpan (5s.)*	0 4½	0 6	0 4½	0 6
Buffelsfontein (10s.)	1 6	1 6	1 6	1 9
City Deep	0 6	0 7½	0 7½	0 7½
Consolidated Main Reef	1 3	1 6	1 6	1 3
Consolidated Murchison (5s.)	2 9	5 3	2 9	5 6
Crown Mines (10s.)	1 6	1 9	1 9	2 0
Daggafontein (5s.)	2 6	2 6	2 3	2 3
Dominion Reefs (5s.)	1 6	1 6	1 6	1 6
Doornfontein (10s.)	1 0	1 6	1 6	1 6
Durban R'd'poort D'p (10s.)	1 6	1 6	1 6	1 6
East Champ d'Or (2s. 6d.)	0 3	0 3	0 3	0 3
East Daggafontein (10s.)	0 7½	0 7½	0 7½	0 7½
East Geduld (4s.)	1 9	1 11	1 9	1 11
East Rand Prop. (10s.)	2 0	2 0	1 9	1 9
Eastern Rand Ext. (5s.)	0 9	1 0	0 9	1 0
Geduld Prop.	5 0	6 3	4 9	5 0
Grootvlei Prop. (5s.)	1 1	1 3	1 1	1 5
Hartebeestfontein (10s.)	3 6	3 6	3 6	3 0
Libanon (10s.)	0 3½	0 3½	0 3½	0 3½
Luipaards Vlei (2s.)	1 1	1 0	1 0	1 0
Marievale Consolidated (10s.)	1 1	1 5	1 4	1 7
Middle Wits (2s.6d.)	0 6	0 6	0 7½	0 7½
Modderfontein B. (3d.)	—	1 0	—	0 6
Modderfontein East	0 9	0 6	0 6	1 0
New Klerksdorp (5s.)	—	0 9	1 0	1 0
New Pioneer Central Rand (5s.)	2 6	—	2 9	1 3
Rand Leases (3d.)*	0 1½	—	—	1 0
Randfontein	2 0	2 3	1 9	2 3
Rietfontein Cons. (3d.)*	—	—	—	0 8
Robinson Deep B (5s. 6d.)	—	—	—	—
Simmer and Jack (1s. 6d.)	—	—	—	—
South African Land (3s. 6d.)	1 6	1 6	1 3	0 6
South Roodepoort M.R. (10s.)	1 1½	1 1½	1 1½	1 1½
Southern Van Ryn	—	0 7	—	0 7
Springs Mines (5d.)*	—	0 4½	—	0 6
Stilfontein (5s.)	1 10½	1 10½	1 10½	1 7½
Sub Nigel (3d.)*	1 6	—	—	1 3
Vaal Reefs (5s.)	1 6	2 0	1 6	2 0
Venterspost (10s.)	0 10½	0 10½	0 10½	0 10½
Village Main Reef (1s. 3d.)	0 0½	—	—	—
Vlakfontein (10s.)	0 11	1 0	0 11	1 0
Vogelstruisbult (3d.)*	1 0	1 0	—	0 10
West Driefontein (10s.)	3 9	4 0	4 3	4 9
West Rand, Ord. (10s.)	2 0	2 3	2 0	2 3
Western Reefs (5s.)	1 3	1 3	1 3	1 3
Witwatersrand Nigel (2s. 6d.)	0 1½	—	0 1½	—

* Capital Repayment.

Speaking at the annual meeting of the CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LTD., held in London last month, the chairman, Mr. Robert Annan referred to the increasing knowledge of the geology of the Witwatersrand goldfields that has been accumulated over the years and emphasized that the search for new areas is being continued. In pursuit of this policy, he said, Consolidated Gold Fields has recently secured options on mineral rights over an aggregate area of 60,000 morgen in a belt to the south of the West Wits. line and of Western Deep Levels, extending from the Farm Doornpoort No. 347 in the east to the Mooi River in the west. This area is to be tested to see if the reef horizons which have been so profitable on the West Wits. line recur at mineable depths as a result of faulting. Exploratory drilling has already been started in the area.

Earlier this month shareholders of KLERKSDORP CONSOLIDATED GOLDFIELDS were informed, with reference to the latest application made to the South African Authorities on September 24 last for permission to become a producer of uranium, that the Minister of Mines has regretted that in view of the surplus output of uranium in the Union it is not possible under present conditions to accept the company as a producer.

Shareholders of the SOUTH AFRICAN LAND AND EXPLORATION COMPANY have been informed of the directors' intention to proceed with the issue of £2,000,000 in notes referred to in the December issue, the necessary resolutions having now been passed. Accordingly they have been offered in the ratio of £4 notes for every five shares held, the offer closing on February 1.

At an extraordinary meeting of TRANSVAAL AND DELAGOA BAY INVESTMENT held on December 30 resolutions were passed increasing the nominal capital of the company from £400,000 to £1,200,000 and authorizing a capitalization issue of 721,500 new shares on a two for one basis.

Speaking in Johannesburg last month the chairman of ASSOCIATED MANGANESE MINES OF SOUTH AFRICA, Mr. S. G. Menell, stated that the company had sold 50% more manganese ore forward for shipment in 1960 than had been exported in the whole of 1959. The company plans to acquire the whole of the shares of FERALLOYS, LTD., one of its customers.

The accounts of WITBANK COLLIERY for the year to August 31 last show a profit of £295,108 and £580,875 available. Of this amount dividends equal to 5s. 4d. a share require £165,229 and after placing £102,189 to reserve there remains a balance of £267,418 to be carried forward. The amount of coal despatched by the company in the year under review was 1,710,733 tons.

In the report of RUSTENBURG PLATINUM MINES for the year ended August 31 last it is stated that in the period the demand for platinum for industrial uses other than in the oil industry recovered from the low levels which prevailed during the period of economic recession in the United States and elsewhere in 1957 and 1958. The improvement has been maintained and demand for the associated platinum-group metals was also at a satisfactory level during the year and has remained so since the year-end. The company's accounts show £2,941,504 available for appropriation, a dividend of 26s. 3d. a share requiring £1,140,037.

Orange Free State.—On December 30 shareholders of the FREE STATE DEVELOPMENT AND INVESTMENT CORPORATION were informed that bore-hole G.Z.1, situated on the western boundary of the Farm Grootvadersbosch 470, in the District of Viljoenskroon and drilled jointly with WESTERN HOLDINGS, had been stopped in foot-wall measures of the Vaal Reef at 7,562 ft. The Vaal Reef was not intersected owing to its displacement by a fault and deflections were being carried out to determine the dip and strike of the fault.

The accounts of FREE STATE GEDULD MINES for the year to September 30 last show a surplus of £5,699,920 and £6,043,545 available, of which dividends equal to 8s. a share require £4,000,000. In the year 972,500 tons of ore was milled and 759,712 oz. of gold recovered. At September 30 the ore reserves were estimated as 2,766,000 tons averaging 20·86 dwt. in value over 44·5 in.

PRESIDENT BRAND GOLD MINING reports a profit of £9,305,984 for the year ended September 30 last, £3,861,000 of the £9,639,070 available being required for dividends equal to 5s. 6d. per stock unit. Output for the year totalled 998,362 oz. of gold from 1,267,500 tons of ore milled, while there was in addition an estimated revenue of £1,095,579 from uranium. At the end of the year the ore reserves were 3,804,000 tons averaging 18·14 dwt. in gold with 0·316 lb. of uranium per ton.

The report of PRESIDENT STEYN GOLD MINING for the year to September 30 last shows a profit of £2,883,906 and £3,116,049 available, dividends equal to 2s. 6d. a share requiring £1,750,000 of this amount. The mill crushed 1,190,000 tons of ore in the year and recovered 463,234 oz. of gold, while there was an estimated revenue of £1,350,972 from uranium. Ore reserves at the end of the year were calculated to be 4,869,000 tons averaging 8·29 dwt. in gold and 0·337 lb. in uranium per ton.

The operations of WELKOM GOLD MINING in the year to September 30 last resulted in a profit of £1,377 847, the accounts showing £1,622,484 available, of which dividends totalling 6d. a share required £306,250. The company milled 1,149,000 tons of ore in the year and recovered 352,133 oz. of gold and uranium worth £1,247,250. At September 30 last the ore reserves were estimated as 3,996,700 tons averaging 7·27 dwt. in gold and 0·338 lb. of uranium per ton.

WESTERN HOLDINGS reports a surplus of £6,535,097 for the year to September 30 last, the accounts showing £6,781,704 available, of which dividends totalling 8s. 6d. a share require £3,185,960. In the year 1,387,500 tons of ore was milled and 838,419 oz. of gold. Ore reserves are given as 4,730,000 tons averaging 16·01 dwt. in value over 47·27 in.

Diamonds.—In the three months to December 31 last DE BEERS CONSOLIDATED MINES, through the Central Selling Organization, effected diamond sales worth £22,729,096, of which £15,465,301 is attributable to gem stones. Total figures for 1959 are given as £91,135,943, gem stones making £63,033,187 of the whole.

Southern Rhodesia.—As was noted in the November issue the second Aerofall mill unit at M.T.D. (MANGULA) was completed last year and production is now running at the target rate of 3,000 short tons of ore per day. In addition, as was originally forecast, working costs are not expected to exceed 22s. per short ton of ore. In a circular last month shareholders were reminded that the construction programme was financed in part by a loan from MESSINA (TRANSVAAL) DEVELOPMENT, the parent company, and the balance outstanding on this account is said now to be approximately £950,000. In order to facilitate dividend payments by Mangula it is proposed to repay this loan from the proceeds of an issue of fresh capital and the board has decided to offer 2,000,000 new ordinary shares of 5s. each at 9s. 6d. per

share in the proportion of one new share for every nine ordinary stock units of 5s. held. The parent company has underwritten the issue and will subscribe all the shares to which it is entitled and any shares arising from fractions.

Last month SELECTION TRUST, LTD., announced that its associated company BIKITA MINERALS (PRIVATE), of Fort Victoria, had purchased the adjoining property owned and operated by George H. Nolan. The newly-acquired property, it is stated, forms part of the same ore-body already being mined by Bikita, but whereas the latter's mineralization contains primarily lepidolite and beryl, with subsidiary spodumene, amblygonite, and pollucite, the new section contains large reserves of high-grade petalite, as well as subsidiary spodumene and eucryptite. The two properties can be readily worked as a single mining operation, it is thought, and Bikita Minerals will now be able to supply all types of lithium ores to glass and other industries as well as to manufacturers of lithium chemicals.

At the beginning of January it was stated that the offer made by the Standard Bank of South Africa on behalf of RIO TINTO (SOUTHERN RHODESIA) for the 4,500,000 fully-paid shares of 2s. 6d. each of the CAM AND MOTOR GOLD MINING COMPANY (1919) had been accepted by the holders of more than 90% of the shares. Rio Tinto (Southern Rhodesia) intends to exercise the statutory right to acquire the remaining shares in due course.

At the annual meeting of the CORONATION SYNDICATE, LTD., held in Johannesburg last month, the chairman said that the company had exercised its option to purchase the whole of the share capital of RIVERSDALE ANTHRACITE COLLIERY (PTY.), LTD. This colliery, which is producing approximately 1,800 tons of anthracite coal per month, is now operating solely for the benefit of the Syndicate.

At an extraordinary meeting of MOTAPA GOLD MINING held in Salisbury on December 14, a special resolution was passed placing the company in voluntary liquidation.

Northern Rhodesia.—At the annual meeting of the RHOKANA CORPORATION last month the resolutions increasing the capital of the company and authorizing the issue of 22,500,018 ordinary shares were approved.

Ghana.—In a circular shareholders of TAQUAH AND ABOSSO MINES have been informed that during the year ended October 30, 1959, steel structures and installations at the company's properties in Ghana were disposed of as scrap metal and the office at Aboso closed. The company's only remaining asset in Ghana, it is stated, is the Huni surface concession, on which stands the housing accommodation to be taken over by the Ghana Government in respect of the balance of £25,762 outstanding from monies advanced by Government for development work while the mine was operating. Negotiations are still proceeding on this matter and once agreement has been reached, a final payment will be made to members and the liquidation of the company completed.

Sierra Leone.—It was stated last month that shipments of iron ore by the SIERRA LEONE DEVELOPMENT COMPANY during October broke the record of 160,620 tons set up in August last. The October shipments totalled 166,515 tons, of which 82,520 tons went to Britain, 30,705 tons to the Netherlands, 29,320 tons to Germany, and 23,970 tons to the United States.

Tanganyika.—Speaking at the annual meeting of TANGANYIKA DIAMOND AND GOLD DEVELOPMENT the chairman, referring to ALAMASI said that in the year to June 30 last the 74,000 loads of overburden was more than double that stripped the previous year. The gravel mined was also increased to 258,000 loads and the treatment of gravels through the plant increased by 25% to 250,000 loads. In spite of a drop in grade from 7·6 to 6·78 carats per 100 loads the recovery of diamonds was increased by almost 2,000 to 16,844 carats. The average price received showed a slight drop from £7·36 to £7·158 per carat, but the gross revenue from the sale of diamonds was increased by approximately £10,000 to £120,583. The new plant should be in operation early this year.

Australia.—At the annual meeting of LAKE VIEW AND STAR last month the chairman said that the Chaffers shaft electrification was expected to result in a saving of 9d. per ton, but that unfortunately it seemed that much of that saving might well be absorbed by rising costs. Since the close of the financial year there have already been two further increases in the basic wage totalling 4s. 8d. per week and it was evident that without the benefits of cheaper hoisting shareholders would be receiving substantially reduced dividends. Provided that costs could be controlled profits should still permit the payment of the current dividend.

For some years past KALGOORLIE SOUTHERN (one of the WESTERN MINING CORPORATION'S associates) has been drilling holes, moderately deep to deep, in the Hannans Lake area a few miles south of the Golden Mile. Eleven holes have yielded information of value both structually and geologically. A new hole, for which a specially-constructed " rig " has been secured, was started on December 18. The drilling site is on an island in the Lake (except in very wet weather the " Lake " is a dry flat surface and the " island " a raised mound). The hole has been started at a steep easterly angle, but at a depth of several thousand feet will flatten to cut across the formations. It will probably take a year to complete the hole, it is thought.

Colombia.—In the September quarter PATO CONSOLIDATED GOLD DREDGING treated 5,471,000 cu. yd. of ground and recovered 27,967 oz. of gold. This brings the output for the nine months to September 30 to 74,893 oz. Dredge No. 4, it is stated, completed its flotation move in August and was at work on its new site on August 19.

Consolidated Gold Fields of South Africa.—It was announced at the end of the year that with effect from January 1 the Consolidated Gold Fields of South Africa will be acquiring the undertaking and assets of its wholly-owned subsidiary—NEW CONSOLIDATED GOLD FIELDS, LTD. As a result of this merger, which, it is stated, is purely a matter of internal re-organization, Consolidated Gold Fields will be the main operating company of the group.

DIVIDENDS DECLARED

* Interim. † Final.
(Less Tax unless otherwise stated.)

African and European Investment Co.—Pref. 3%, payable Feb. 15.

†**Amalgamated Collieries of South Africa.**—3s., payable Feb. 15.

†**Apex Mines.**—2s., payable Feb. 4.

†**Associated Manganese Mines of South Africa.**—Pref. 2·1d., Ord. 1s. 10d.

***Central South African Lands and Mines.**—3d.

***Charterland and General.**—Pref. 3%, payable Jan. 15.

†**Consolidated Diamond Mines of South-West Africa.**—Pref. 4½d., Ord. 15s., payable Feb. 15.

†**Corner House Investment Co.**—6d., payable Feb. 4.

†**Coronation Collieries.**—7½d., payable Feb. 15.

De Beers Consolidated Mines.—Pref. 10s., payable Jan. 28.

***Lydenburg Gold Farms.**—1d., payable Mar. 15.

***Malayan Tin Dredging.**—5%, payable Mar. 1.

***Natal Coal Exploration Co.**—4d., payable Feb. 15.

***Nchanga Consolidated Copper Mines.**—2s. 4·8d., payable Feb. 11.

***New Witwatersrand Gold Exploration Co.**—1½d., payable Mar. 15.

***Phoenix Colliery.**—10½d., payable Feb. 4.

†**Rand Mines.**—3s., payable Feb. 4.

***Rhodesia Broken Hill Development Co.**—4·8d., payable Feb. 11.

***Rooiberg Minerals Development Co.**—2s., payable Feb. 4.

***South African Coal Estates.**—1s. 6d., payable Feb. 15.

***South Witbank Coal Mines.**—6d., payable Feb. 23.

***Southern Malayan Tin Dredging.**—5%, payable Feb. 26.

†**Springbok Colliery.**—1s., payable Feb. 15.

†**Transvaal Consolidated Land and Exploration Co.**—2s. 3d., payable Feb. 4.

***Transvaal Navigation Collieries.**—3·6d., payable Feb. 9.

†**Tweefontein United Collieries.**—9d., payable Jan. 29.

***Vierfontein Colliery.**—4d., payable Feb. 15.

†**Vryheid Coronation.**—6d., payable Feb. 15.

†**West Rand Consolidated Mines.**—Def. 127s. 6d., payable Feb. 4.

***West Witwatersrand Areas.**—1s. 10½d.

***Western Mining Corporation.**—6d. (Aust.), payable Feb. 19.

METAL PRICES

January 8.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	28	10	0
Silver		6	8½
Gold	12	10	7½
Wolfram (U.K.)		—	
(World)	7	13	0

Tin, Copper, Lead, Zinc } See Table, p. 48.

Fifty Years of Extraction Metallurgy

A brief review and a look at current trends.

C. W. Dannatt, A.R.S.M., D.I.C., F.R.I.C., M.I.MM.[1]

Introduction

The under-developed nations, which constitute about three-quarters of the population of the world, consume an almost negligible amount of metal, yet, during the past 50 years, the demand for metals has quadrupled while the population of the principal metal-consuming nations has increased by less than a half. Moreover, the demand is not only for greater tonnages, but also for a greater variety of metallic materials, and many of the metals now in use were, at the turn of the century, little more than chemical curiosities. It is hardly surprising therefore that there have been more notable advances in metallurgical practice during the period under review than in the whole previous history of this ancient art.

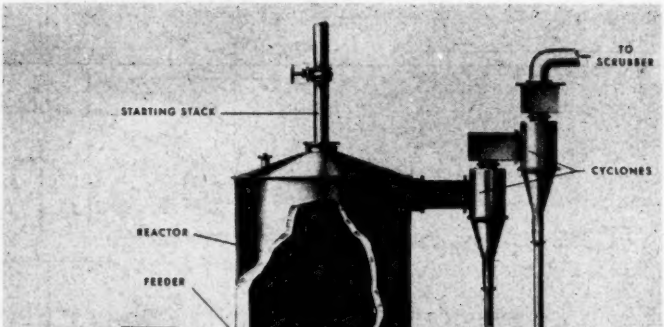
At the close of the 19th Century many relatively rich ore deposits were still available, but leaner ores were mined and these were concentrated by gravity or, where applicable, magnetic methods. Preferential separation, however, is seldom possible with gravity concentration, so the concentrates were usually of only moderate grade and were sometimes so complex that they were not amenable to the chemical treatments that were then available. The introduction of preferential flotation was therefore an advance of the greatest importance, for it rendered profitable not only many low-grade deposits, but a number of rich complex ores that had been previously unworkable. It is interesting to recall that the American company which owned the Sullivan mine went into liquidation because the ore was too complex to be profitable, and the mine was taken over by the Canadians at an almost nominal figure only a few years before the introduction of flotation made it one of the most valuable mineral properties in the world. With improvements in flotation techniques concentrates have become cleaner and of finer size. Cleanliness eases the subsequent treatment, but decreasing particle size accentuates the difficulties that had already, with gravity concentration, forced the re-introduction of reverberatory furnace smelting for copper concentrates, the sintering of lead concentrates, and the development of dust collection by various means, including electrostatic precipitation. Flotation may necessitate changes in the flow-sheet, but as it eases treatment it has had little effect upon the techniques used, so the familiar statement that " flotation has revolutionized the practice of extraction metallurgy " is a palpable exaggeration.

The general trends in metallurgical practice can best be illustrated by a few typical examples of the improvements and innovations introduced into the various classes of operations. As would be expected, they are mostly due to the growing understanding and better appreciation of the scientific principles on which these operations are based.

Roasting

Few of the many mechanized furnaces in use at the beginning of the century have survived. The Edwards furnace, owing to its gentle stirring action and low dust loss, is popular for roasting auriferous concentrates, and the single-deck rotating-hearth furnace is satisfactory when little roasting action is needed, as in the removal of arsenic from cassiterite concentrates. The revolving cylindrical furnace has been largely used for low-temperature volatilization work, as in the treatment of arsenic or mercury ores. The multiple-hearth type of furnace, of which the Wedge is the most popular, has proved to be the most adaptable, and water-cooling has given place to air-cooling for the rabble arms as the heated air from these arms can be

[1] Emeritus Professor of Metallurgy, Royal School of Mines: Past President of the Institution of Mining and Metallurgy.



The FluoSolids Reactor.

introduced to any hearth where speedier action is desired. Stellite inserts in the rabble blades protect them from too rapid abrasion, and it is now usual to conserve heat by insulating the furnace casing with rock wool or infusorial earth.

For combined roasting and sintering operations the Dwight-Lloyd machine was already ousting the various pot-roasting processes, but the feed was reduced to a suitable content by a preliminary roast, usually in furnaces of the Wedge type. This duplication of euipment was avoided for lead concentrates, with which a relatively high proportion of diluents is unobjectionable, by mixing the furnace fluxes into the charge and using two machines in series, the first giving a rapid treatment to a thin bed and the second a slower treatment to a thick bed. In the case of zinc diluents would occupy valuable space in the retorts, so the practice adopted is to return to the head of the machine a sufficient quantity of crushed sinter to reduce the sulphur in the feed to a suitable percentage.

The gases from a zinc roaster are used for sulphuric acid manufacture, and an interesting innovation at the Avonmouth plant of the National Smelting Company (1) [1] was to divide the wind-box of the down-draught machines, returning the gas from below the discharge end to a hood above the pallets at the feed end. This slows combustion at the commencement of sintering by providing a gas somewhat depleted in oxygen, and also enriches the gas in sulphur dioxide before it passes to the sulphuric acid plant.

When zinc is recovered electrolytically some degree of sulphating roasting is desired to make good the loss of acid during leaching, but the oxidation of the sulphide must be complete to ensure satisfactory dissolution. It was known that oxidation is most rapid while sulphide particles are dropping through a hot oxidizing atmosphere, and at Trail (2), where roasting was effected in Wedge furnaces, advantage was taken of this fact by removing the four central hearths to form a large combustion chamber. In this method of " flash roasting " concentrates are fed as usual, dried on the two top hearths, and discharged to a ball-mill, where any agglomerations are broken down. The fine hot material is then blown, with air, through pulverized-fuel burners into the combustion chamber, where it roasts autogenously as it falls to the hearth, and it is raked thence either to the discharge or to the lowest hearth, where it can be further sulphated in a sulphur dioxide-enriched atmosphere. Dusting loss is heavy, but the dust is recovered before the gases pass to the waste-heat boilers. It was found that only eight of these " flash roasters " were

[1] A list of references appears at the end of this review.

needed to replace the original 25 eight-hearth Wedge furnaces.

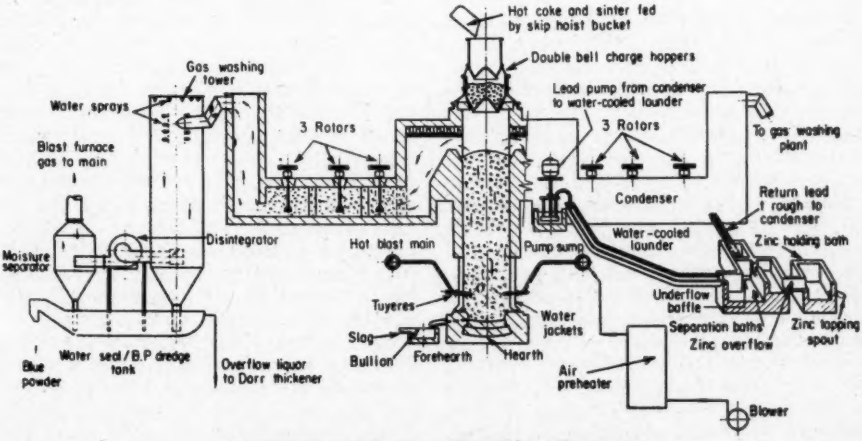
The most important advance in roasting techniques is the adaptation of "fluidization" to metallurgical operations. The reactor (3) is a short shaft into which air is blown below a distributor, or perforated grate, at the base. A fire having been started on this grate, pulverized charge is admitted at one side, dry, wet, or as a slurry, to oxidize in the rising gases which maintain "fluid" conditions. Eventually the charge overflows the discharge opposite the feeder, while the exit gases from the top of the shaft pass through cyclones from which the collected dust joins the main discharge. Close control is possible by (*a*) varying the particle size, (*b*) adjusting the proportion of combustible material in the charge, (*c*) altering the charging rate and therefore the duration of the treatment, (*d*) changing the air pressure, or (*e*) enriching the air with oxygen. Dead roasting, sulphating roasting, or partial roasting can be effected with high efficiency.

Smelting

(i) *Blast-Furnace Smelting.*

The width of a blast-furnace for copper or lead smelting has been restricted by the inability of the air blast to penetrate a greater thickness of charge than about 4 ft. 6 in. to 5 ft., as too strong a blast would raise the smelting zone and cool the fused products dropping past the tuyeres. Increased capacity has therefore been attained by lengthening the furnaces, and an interesting development in the pyritic smelting of lump copper ores was effected at Anaconda (4), just before the first world war, to handle a largely increased ore supply. There was a battery of seven furnaces, each 4 ft. 8 in. by 15 ft. at the tuyeres, spaced 21 ft. apart, and two of these were joined by building in a hearth and superstructure between them, forming one furnace 4 ft. 8 in. by 51 ft. at the tuyeres. This was so successful that two more furnaces were joined and, finally, the three remaining furnaces were combined to form the largest copper blast-furnace ever constructed, 4 ft. 8 in. by 87 ft. at the tuyeres. This furnace had a capacity of over 3,000 tons per day and as the original tap-holes were retained it had the advantage that a worn jacket could be replaced or repaired without a complete shut-down. The air supply would be cut to the tuyeres at and opposite the damaged section, so that the charge at that point solidified. Once the repair was effected air would be readmitted to the tuyeres in turn, starting from the sections where smelting had been continued.

Recently, however, increased capacity has been obtained at Port Pirie (5) by a new design. The lower portion of the new lead blast-furnace has the usual width of 5 ft., but 5 ft. above the hearth the furnace is widened to 10 ft. and a second row of tuyeres is introduced. A central column of unsmelted charge passes to the lower smelting zone, where the smelting rate is so accelerated by the molten material dropping from above that furnace capacity has been doubled.



Diagrammatic Layout, Zinc Blast-Furnace.

An interesting development in iron smelting is the use of increased top pressure to reduce gas velocity through the charge and so decrease dusting loss (6). A greater weight of air can be blown into the furnace with a resulting economy in coke consumption, and it is claimed that metal production has, in some cases, been increased by over 20%. Some difficulty is experienced in maintaining gas-tight conditions at the furnace top, but with an increasing use of iron-ore beneficiation dust loss from the pelletized concentrates becomes a major problem, and this technique may provide a satisfactory solution.

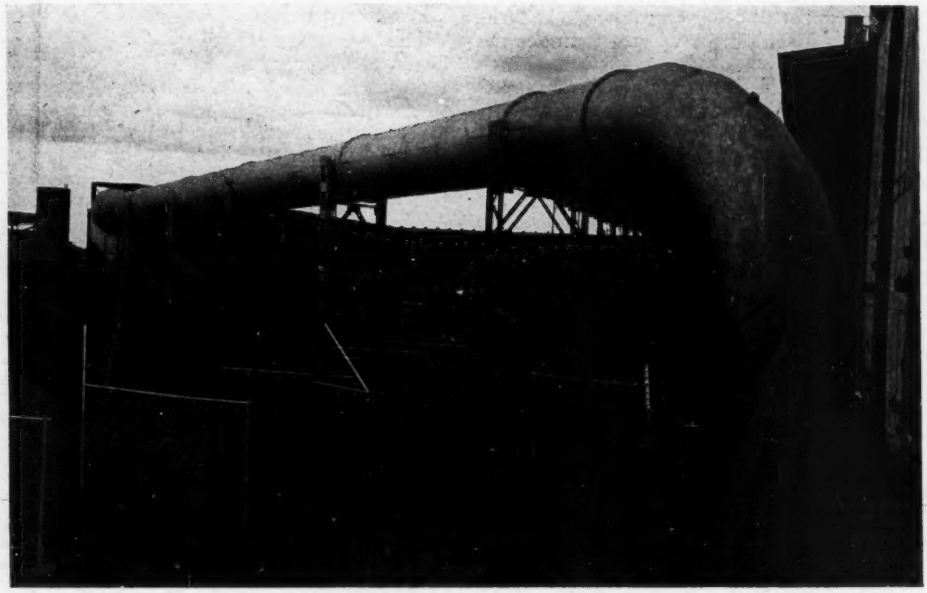
The outstanding achievement, however, is the development of the zinc blast-furnace by the Imperial Smelting Corporation (7). A close study of the conditions under which zinc vapour will remain unoxidized in mixtures of carbon monoxide and carbon dioxide showed that zinc could be volatilized from a complex sinter while smelting for lead. The furnace top must, of course, be sealed to prevent oxidation of the zinc vapour which is condensed in a spray of molten lead. This lead circulates through a water-cooled launder to a separating bath and thence back to the condenser. Miscibility decreases with temperature, so molten zinc forms a second liquid phase as the lead cools in the launder and is removed in the separating bath. As lead and zinc so frequently occur in such intimate association that preferential flotation cannot effect a clean separation between them, the importance of this development is evident.

(ii) *Reverberatory Furnace Smelting*

Now that lump ores are no longer available, the copper blast-furnace must be considered obsolete and the advantages of pyritic smelting are lost, for sufficiently oxidizing conditions, together with the necessary smelting temperature, cannot be attained in the reverberatory furnace. For the first 20 years of the century a preliminary roast was always needed for sulphide concentrates, but with improved flotation techniques " wet charging ", or the direct smelting of raw concentrates (8), can be adopted, provided the copper content is high enought to give a matte of satisfactory grade. Previously, two methods of operation were developed, " deep bath smelting " with centre charging and, as granular charges gave way to finer material and dusting losses became serious, " side charging " down the walls of the furnace. This latter procedure keeps the charge away from the rapid gas stream through the centre of the furnace, and by allowing charge-piles to form along the walls protects the brickwork from direct attack by the fused bath.

The width of a furnace arch is limited by the hot strength of the brickwork, and on the assumption that furnace size governs capacity longer and longer furnaces were built, up to 143 ft. 2in. at Anaconda (9). When it was realized that capacity depends not upon size but upon the rate at which fuel can be usefully burned, width became of more importance than length, which is now governed by charging conditions and the need to keep unsmelted charge from the skimming bay. Width was increased to about 23 ft., and length was reduced to about 100 ft., and this, with the adoption of gas, oil, or powdered-fuel burners, raised capacity to nearly 1,000 tons per day wth a fuel ratio of about 15%. A major advance was the adoption of the suspended basic roof (10), sheet-steel " cans ", packed with chemically-bonded unburnt magnesite, being suspended by " hangers' " from rods above the furnace to replace the arch bricks, the skewbacks, and the upper part of the side walls. By adjusting the length of the hangers any desired roof contour can be adopted, and badly corroded cans are knocked into the bath and readily replaced. The Noranda furnaces were widened to 35 ft. without a shut-down by building the wider walls, extending the roof, and smelting out the original brickwork, the daily capacity being increased to over 2,000 tons of dry charge with a fuel ratio of 10·3% (11).

With larger and fewer units furnace life becomes of increasing importance and every effort is made to minimize attack on the roof and walls. The latter are protected by the ore piles inside the furnace and by water-cooled jackets along the bath line, but dust attack is a major problem. The cleaner the concentrates produced in the mill, the more basic and more corrosive will be the dust, and with finer concentrates dusting loss is increased. Wet charging is effective in reducing this loss as the damp material tends to agglomerate, but there is danger of damage from explosions inside the furnace. More fuel is required, but the demand for power is so large in a modern mechanized plant that the additional waste heat can usually be usefully absorbed. A basic roof is less readily attacked, but silica arches and side walls are still preferred in most United States' plants where " gun-feed " charging (12) and " hot-patch-



Blast-Furnace Flue System, Mount Isa.

ing " (13) have been widely adopted. In the former, dry charge is blown, with compressed air, on to the surface of the bath through a telescopic tube that is projected through feeding ports in the side walls, and in the latter, corroded areas are sprayed with a silica slurry that contains a small percentage of bonding material. The furnace temperature transforms the silica of the slurry to tridymite which grows on to the tridymite crystals in the brick, forming a firm and satisfactory bond. By such means furnace life, in general, has been greatly extended, and the Noranda furnaces with suspended basic roofs have run for upwards of six years without a shut-down.

The successful development of flash roasting revived interest in the early patents on proposals to develop flash smelting, a procedure that is now successfully established. Combustion is assisted by using either preheated air or unheated oxygen, but, essentially, the procedure is the same in each case. The furnace at Copper Cliff (14) has a short shaft as a central gas off-take, and concentrates are charged at one end and pyrrhotite at the other, both through powdered-fuel burners and with almost pure oxygen. Matte is tapped centrally and, to maintain the gas seal, slag is tapped below slag level from beneath the pyrrhotite burners, so that it is washed by the falling particles of iron sulphide. The oxygen supply is adjusted to burn about half the sulphur in the charge and so give a matte of the desired grade, and the furnace gases carry about 75% of sulphur dioxide which is recovered in liquid form for the market.

(iii) *Aluminothermic and Similar Methods.* The Goldschmidt process for the reduction of metallic oxides with aluminium powder (15) has proved of value for the production of either a metal or a ferro-alloy, and similar procedures have been developed using as a reducing agent metals of greater oxygen affinity—such as, magnesium, calcium or sodium, or strongly reducing compounds like calcium hydride. When necessary the reduction is effected under vacuum or in an inert or reducing atmosphere. Such methods are of particular value for some of the more reactive metals, a number of which form carbides if they are reduced with carbon.

Bessemerization

The basic Bessemer process retained its popularity on the Continent owing to the

abundance of phosphoric iron ores and the relative lack of scrap steel, but it suffers the objection that it produces a steel of high nitrogen content that is subject to strain-age-embrittlement. Nitrogen is absorbed from the air blast towards the end of the blow, and it was thought that oxygen enrichment, by decreasing the nitrogen in the blast, would improve the steel. Tests showed that the improvement was insignificant unless nitrogen was almost eliminated, but various procedures have been developed, including oxygen enrichment of the blast, blowing with a mixture of oxygen with either carbon dioxide or super-heated steam, and pure oxygen alone. The first of these has proved beneficial for high-phosphorous irons, and pure oxygen has had marked success with the lower-phosphorous irons. In the Linz-Donawitz (16), or L.D., process the converter has no tuyeres, a high-velocity jet of oxygen being blown through a water-cooled probe onto the surface of the metal. A converter of 25–30 tons capacity produces 55 tons of steel per hour.

Fifty years ago the basic-lined copper converter was a novelty, and it was normal practice to blow mattes of rather high grade to minimize wear on the lining. The formation of a protective layer of magnetite, by blowing a first charge of low-grade matte without any flux, made it possible to use the excess heat liberated from mattes of medium grade for including scrap and cupriferous residues in the charge. Siliceous copper and precious-metal ores came to be used as fluxes, partly for the collection of their values and partly as a means for passing silica to the smelting furnace in the returned converter slag. High bismuth in the Rhodesian concentrates led to the use of high temperatures in pre-heated converters for eliminating bismuth in the early stages of the conversion of medium-grade mattes (17).

An interesting development in the treatment of nickel-copper mattes is the replacement of the Orford process at Copper Cliff (18). The binary phase diagram of the sulphides of these two metals shows that when β nickel sulphide transforms to the α variety at 535° C. the solid solubility of copper sulphide drops to a negligible quantity. The converted " Bessemer matte " is now held close to this temperature for a prolonged period, whereby transformation is completed and crystal growth is promoted. The cooled matte is then ground and the two sulphides are separated by flotation.

Volatilization Processes

The horizontal retort process for zinc demands heavy labour and necessitates the use of large furnaces to hold the numerous small retorts, for a high temperature is essential, and large retorts lack sufficient strength to carry the charge without supports that would impede heat transfer. Further, the process is wasteful in fuel consumption, much blue powder is formed, and the product is not of high purity. The New Jersey Zinc Company (19) brought into operation large vertical retorts which are mechanically operated and effect a considerable fuel economy. Sinter from the Dwight-Lloyd machines is briquetted with coal and charged, hot, through a trapped hopper into the 75 ft. vertical retort, the central 25 ft. of which are heated with producer gas. The gas leaving the retorts is rich in carbon monoxide and hydrogen, and it is passed through a condenser where zinc is collected through scrubbers to recover the small content of blue powder, and finally joins the main supply of producer gas passing to the heating chambers. The hot gases from these chambers are used for coking and drying the briquettes, the coal in the briquettes thus providing about 20% of the total heat required. As in the horizontal retort process, cadmium passes into the zinc and, although of rather better quality than horizontal retort metal, the zinc is not pure enough use in die-casting alloys. Later, the same company developed a refluxing treatment for spelter (20) in two centrally-heated refluxing columns fitted with silicon carbide trays, liquid metal dripping downwards while metal vapour rises. By close temperature control, zinc and cadmium are separated from a zincy lead in the first column and, after condensation, cadmium is volatilized from high-purity zinc in the second column.

The St. Joseph Lead Company (21) developed an electro-thermic method for avoiding the major objections to the horizontal retort process. Sinter and coke are pre-heated and fed to a short shaft furnace that is heated by three single-phase electric currents passed between electrodes at the top and bottom of the shaft. An off-take, just below the upper electrodes, leads to a water-cooled condenser where zinc is collected.

For material that is of too low a grade for treatment in retorts the Waelz process (22) has met with success. Volatile metals or metallic compounds are removed in a rotating kiln by heating the charge, without fusion,

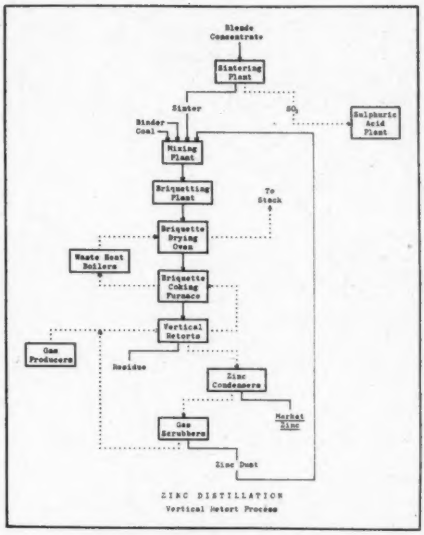
by means of a crushed fuel and, when necessary, an auxiliary burner. While this treatment is used for a number of purposes its principal application is for the volatilization of zinc, which re-oxidizes immediately in the furnace atmosphere and is collected as fume. Lead usually contaminates the fume, but this can be removed by a second treatment at about 1,300° C., which also densifies the zinc oxide. A somewhat analagous operation is slag fuming (23), in which zinc-bearing slags from the smelting furnace are transferred, molten, to a water-jacketed fuming furnace which is equipped with tuyeres. Air and pulverized fuel, proportioned to produce carbon monoxide, are injected through the tuyeres and reduce the zinc which, entering the gas bubbles, rises to the surface where it re-oxidizes. As in the Waelz process lead is also recovered in the zinc fume.

Increasing demand for light metals and alloys by the aircraft industry stimulated interest in magnesium production and gave rise to several new methods, one of the most interesting being the Pidgeon process (24). Essentially this is the direct reduction of magnesia with silicon, but under normal conditions a temperature exceeding 2,000° C. would be needed and the magnesium vapour produced would immediately re-oxidize. In vacuo the temperature can be reduced to about 1,100° C. and re-oxidation of the magnesium is avoided, but the silica produced will combine with, and retain, an equivalent weight of magnesia. Using ferro-silicon as a cheap form of silicon, and dolomite as a less costly source of magnesia, the silica combines preferentially with the lime, liberating all the magnesium and aiding the reduction to metal. Cylindrical retorts of a nickel-chromium-iron alloy are used, and the magnesium vapour is condensed in a water-cooled extension outside the furnace.

Another form of volatilization reduction is the Kroll process (25) which takes advantage of the volatility of a chemically purified chloride prepared by chlorination of the oxide, in the case of titanium or the carbo-nitride for zirconium. The chloride vapour is admitted to a vessel containing molten magnesium under an inert atmosphere, and the exothermic reaction, which can be represented by the equation—

$$TiCl_4(g) + 2\,Mg(l) = Ti(s) + 2\,MgCl_2(l),$$

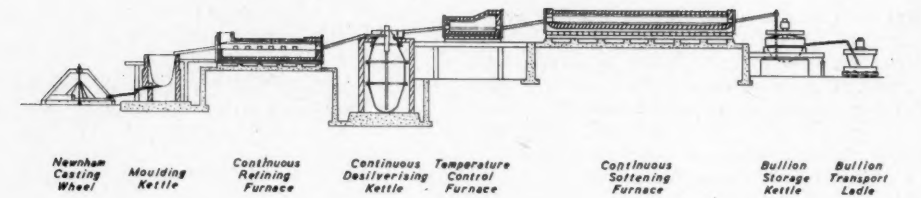
provides the metal in powder form. Most of the magnesium chloride can be tapped from the base of the container, the remainder, with any residual magnesium, being subsequently removed by vacuum distillation, leaving a metallic sponge.

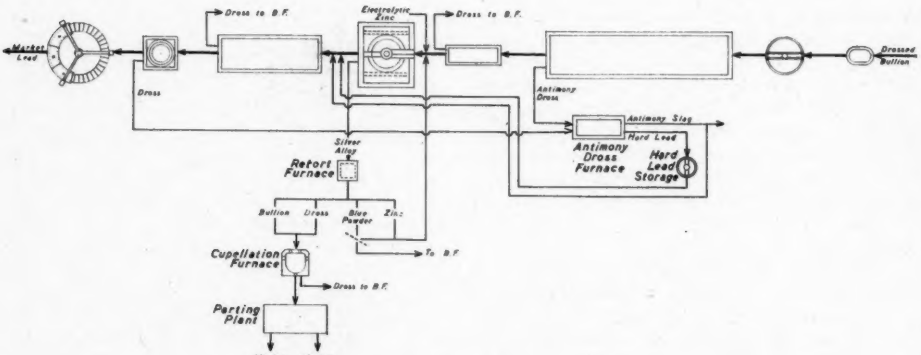


Vertical Retort Distillation.

Hydrometallurgy

The most important hydrometallurgical process in use 50 years ago was the relatively new cyanide process, "sand and slime" treatment still being common, although "all sliming" was soon to gain preference. Filter presses and intermittent suction filters rapidly gave place to continuous thin-cake filters, and de-aeration became combined with the use of zinc dust in place of zinc shavings in the Merrill-Crowe process. The invention of the Dorr continuous thickener led to the introduction of continuous counter-current decantation, a cheaper operation than filtering for large tonnages of low-grade ores leached with solutions of low cyanide strength. The milling of complex ores has been greatly simplified by the incorporation of flotation in the flow-sheet, for barren or auriferous base-metal minerals or cyanicides can be separated for sale, discard, or special treatment, thereby reducing cyanide consumption and cheapening the operations. These advantages were well illustrated at the mill of the Lake View and Star mine (26), where dry grinding, roasting, and cyanidation were replaced by wet grinding, flotation, and discard





Continuous Lead Refining, Port Pirie.

of the tailings, the concentrate being dried, roasted, and cyanided. The daily tonnage was increased from 500 to 1,500 tons, and costs were reduced from 16s. to 6s. per ton with a recovery of 90% of the gold.

Hydrometallurgical operations are of growing importance, for most of the more reactive metals require prolonged and rather complicated chemical treatments for the separation of impurities. Two techniques adapted from large-scale chemical operations are of particular interest. Ion exchange (27), used in Germany during the recent war for the recovery of copper from the waste solutions of a rayon mill, now has a number of applications for obtaining a cleaner concentrated solution from a dilute impure solution. The required metal is removed, either by replacement of the cation in the resin or, if it forms a complex anion, by replacement of the anion. This procedure has been of particular value in uranium extraction and, although costly and still restricted in its applications, must be expected to gain wider use. Much the same may be said of " solvent extraction ", which is the liquid/liquid counterpart of counter-current decantation (28). An aqueous solution of the salts of two or more metals is passed counter-current to an organic solvent that is immiscible with water and will dissolve one, or some, of these metals. Repeated contact makes a complete separation possible and, by reversing the treatment with a suitable aqueous solvent, the metal, or metals, in the organic solvent can be recovered in the aqueous phase, regenerating the organic solvent. This method has been applied successfully to such difficult separations as those of hafnium from zirconium, niobium from tantalum, and plutonium from uranium.

Dissolution is usually favoured by increase of temperature and pressure, particularly when solution is assisted by the presence of a gaseous phase such as oxygen in the atmosphere, and " pressure leaching " at temperatures near, or above, the boiling point of water has achieved notable successes (29). Uranium can be dissolved from pitchblende, and such metals as copper, nickel, and cobalt can be leached from their sulphides in either acid or ammoniacal solution. The converse, precipitation, can also be readily effected with a gaseous precipitant such as hydrogen or hydrogen sulphide, the partial pressure of the precipitant being increased.

Electro-metallurgy

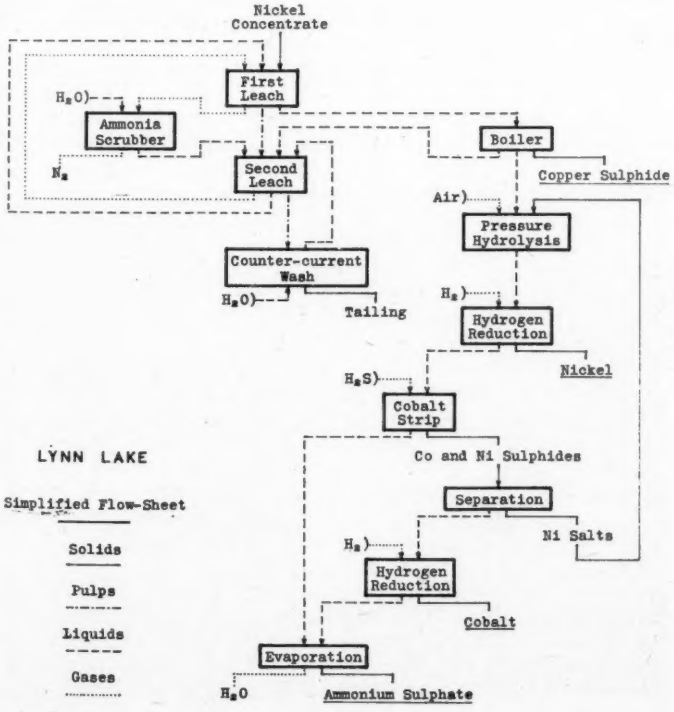
There has been a steady increase in the

application of electric power to metallurgical operations, particularly in those areas where fuel is less readily available than water-power, as in Scandinavia or Finland. Electricity has evident advantages, both for the design of complicated equipment and for close control of operations, and electric smelting and refining furnaces have become increasingly popular, while electric heating is favoured for many of the novel appliances used in recovering the less common metals. Electrolytic refining was already established for copper and lead, but the heavy demand for pure zinc in the production of cartridge brass during the first world war resulted in the rapid development of the electrolytic zinc process, and this was followed by the gradual introduction of electrolytic processes for the recovery or refining of a number of other metals. Of particular interest is the recently adopted procedure for recovering nickel and sulphur from cast anodes of nickel matte (30). The anode decays to a sponge of elemental sulphur, while the nickel forms a smooth adherent deposit on a sheet-nickel cathode.

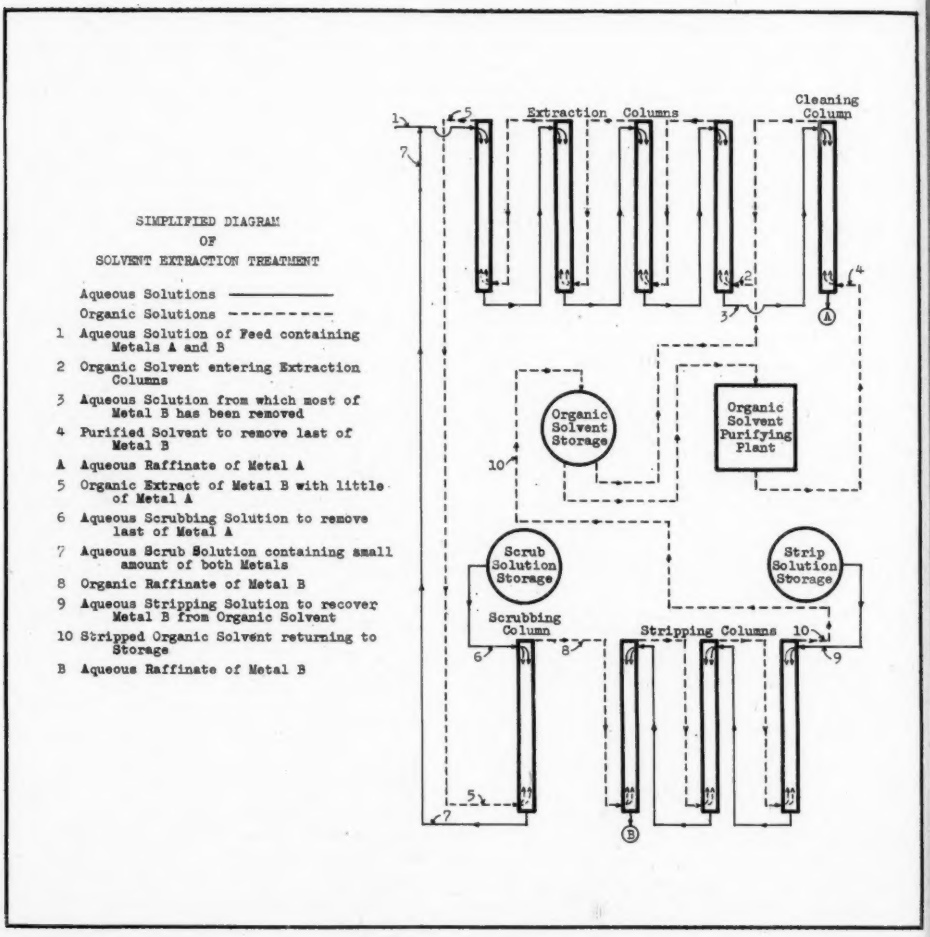
Magnesium is mostly produced by electrolysis from a fused chloride bath, a method that originated in Germany (31). The magnesia obtained from magnesite, dolomite, or seawater is chlorinated with the chlorine liberated from the cells, dehydrated, and electrolyzed at about 725° C. The light magnesium metal rising to the surface is deflected by sheet-iron hoods to separate it from the chlorine with which it would normally react.

Refining

There have been more interesting developments in the refining of lead blast-furnace bullion than in the refining of other metals. These include the Harris process (32) for softening with alkaline fluxes, the Betterton process (33) for dezincing with chlorine gas, vacuum dezincing (34), in which zinc is "boiled" out of the lead at 600° C. under reduced pressure to be condensed on the water-cooled cover of the kettle, and the Kroll-Betterton process (35) for the removal of bismuth from refined lead by the forma-



Pressure Leaching : Lynn Lake.


SIMPLIFIED DIAGRAM
OF
SOLVENT EXTRACTION TREATMENT
Aqueous Solutions
Organic Solutions
1 Aqueous Solution of Feed containing Metals A and B
2 Organic Solvent entering Extraction Columns
3 Aqueous Solution from which most of Metal B has been removed
4 Purified Solvent to remove last of Metal B
A Aqueous Raffinate of Metal A
5 Organic Extract of Metal B with little of Metal A
6 Aqueous Scrubbing Solution to remove last of Metal A
7 Aqueous Scrub Solution containing small amount of both Metals
8 Organic Raffinate of Metal B
9 Aqueous Stripping Solution to recover Metal B from Organic Solvent
10 Stripped Organic Solvent returning to Storage
B Aqueous Raffinate of Metal B
Extraction Columns
Cleaning Column
Organic Solvent Storage
Organic Solvent Purifying Plant
Scrub Solution Storage
Strip Solution Storage
Scrubbing Column
Stripping Columns

Solvent Extraction.

tion of calcium-magnesium-bismuth crusts. The most important development in this field, however, was the introduction of continuous desilverization at Port Pirie in 1932 (36), a procedure that involves the simultaneous operations of continuous softening and continuous dezincing. The ternary lead-silver-zinc equilibrium diagram shows a large immiscibility range in which, on cooling, an alloy of given composition will separate along a tie-line to give two immiscible liquids, one rich in zinc and relatively rich in silver, while the other contains little of either of these metals. This diagram suggested the possibility of the operation which is carried out in a tall " kettle " with a siphon-pipe rising centrally from the bottom to an outlet near the top, the kettle temperature being graded from 600° C. at the top to about 327° C. at the bottom. Molten softened bullion enters the kettle through a layer of zinc, cools as it sinks to the bottom, where the solubility of silver and zinc is a minimum, and is reheated as it rises in the siphon. Argentiferous zinc floats to the surface whence it is skimmed, when it contains 6,000 oz. of silver per ton, about twice the silver content of the usual Parkes crusts, thus easing and cheapening the recovery of silver.

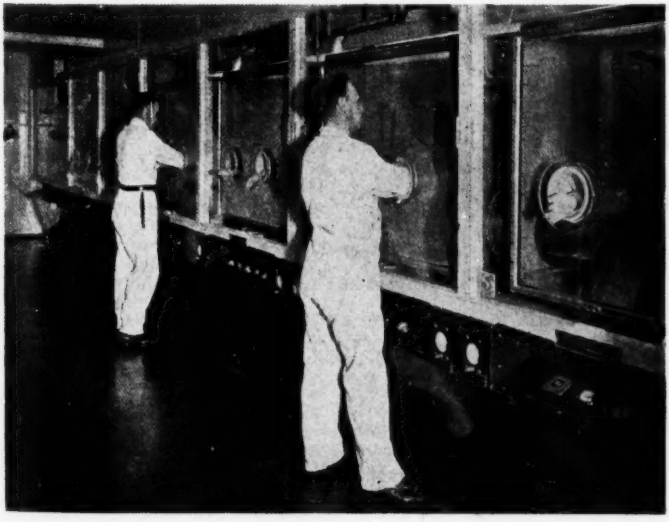
Refining s seldom satisfactory with the less common metals, for they are often associated with equally reactive metals of their own group, all of which are usually more reactive than the other impurities present. A chemical separation usually precedes the reduction, and an interesting example of such a preliminary treatment is the recovery of plutonium from the burned fuel rods of a " breeder " reactor (37). The uranium rods, which contain about 0·03% of plutonium, are stored in water for several weeks to allow decay of the short-lived products of irradiation and then, after solution in nitric acid, both uranium and plutonium are removed by solvent extraction in dibutyl carbitol. The plutonium is then preferentially reduced and, on retreatment, only uranium is extracted. The plutonium in the aqueous solution is further purified by repeating the extraction, and is then converted to fluoride and reduced to metal with metallic calcium. Care must be taken to avoid loss as dust or fume and to prevent toxic effects on the operators, and fissile material must not be handled in large quantity. The final treatment is therefore given, under slight suction, in small stainless-steel cupboards fitted with perspex windows in which are rubber sleeves to enable the operators to handle the materials with immunity.

The van Arkel process (38) refines certain reactive metals through the volatility and instability of their iodides. Crude metal, obtained by some such reaction as the reduction of the oxide with calcium, is reacted with iodine and vapourized, the vapour being passed into a vessel in which fine filaments of the metal being refined are suspended, centrally, and heated to high temperature by an electric current. The vapour decomposes on contact with these filaments, depositing the metal and releasing the iodine for further action on the crude metal. In the case of zirconium the reaction may be represented as follows :—

$$\underset{\text{(crude)}}{Zr} + 2\,I_2 \xrightarrow{\text{at } 200^\circ\text{ C}} \underset{\text{(vapour)}}{ZrI_4} \xrightarrow{\text{at } 1{,}300^\circ\text{ C}} \underset{\text{(pure)}}{Zr} + 2\,I_2$$

(After G. L. Miller) (38)

One of the most attractive refining treatments, as yet restricted to small-scale work, is " zone refining " (39). This depends upon the fact that, in most alloys, certain constituents will solidify preferentially from a melt, while others will remain in the liquid phase. If therefore a bar of metal is fused for a short portion of its length and this zone of fusion moves along the bar, constituents of the former kind will segregate to the cooling portion while those of the latter kind will be carried forward in the molten portion. By passing, and repassing, a suitably supported bar through a series of induction coils, each of which causes local fusion, a high degree of refinement can be attained.



Plutonium Cupboards.

Conclusions

While mention has been made of no more than a few of the many advances in extraction metallurgy that have characterized the past half-century, even so brief and superficial a review will give a general picture of the trends that have been followed and the objectives that have been sought, and can give some indication of the lines of development that may be expected in the near future.

Considering, first, the more familiar base and precious metals, these are, in the main, recovered by the same procedures that were used 50 years ago, and developments have mostly been aimed at increasing production either by replacing batch by continuous treatments, as in the adoption of the countercurrent principle in hydrometallurgy or the development of continuous desilverization, or by the use of units of greater capacity, such as larger leaching vats or wider smelting furnaces, while other operations, such as the vertical retort process, combine both these desiderata. Continuous treatments have stressed the advantages of automatic control, while the use of larger units has accentuated the need to compensate for the increased capital expenditure by ensuring a longer working life. This need has given rise to such improvements as rubber linings for the prevention of abrasion, the use of more expensive, but better, refractories, and, in reverberatory smelting practice, water-cooling of the refractories, hot-patching, and the suspended basic roof. It is practical experience under operating conditions that focuses attention on the defects of a particular process and calls for such improvements as these, and further developments on the same or similar lines must be expected, not only for the so-called " classical " methods of treatment but also for the newer and more specialized techniques, some of which are, as yet, barely out of the experimental stage.

While the rapid growth of scientific knowledge has played a major part in improving methods of operation, it is also the basis from which alternative procedures are evolved, and it has given rise to such operations as flash smelting, improved methods of lead refining, and the growing use of oxygen. Lastly, there are procedures that have proved their value in other branches of technology and have then been adapted to metallurgical requirements, such as fluidization from the petroleum industry, or ion exchange from the chemical industry.

Turning to the " newer ", or more reactive, metals, few of these are amenable to the established methods of extraction and it is difficult to generalize on the methods used, for most of the metals present individual problems. One fact, however, is evident. These metals are usually associated with equally reactive impurities, so the normal sequence of reduction followed by refining is seldom suitable, and purification must generally precede reduction. These preliminary treatments are mostly hydrometallurgical, so it is obvious that hydrometallurgy is becoming of increasing importance. Moreover, with improving techniques, such methods will find application in the recovery of the more common metals, particularly when the ores are complex and by-products may be recovered, the adoption of pressure leaching at Sherritt Gordon being a case in point. This trend has received general recognition, and has given rise to the saying that the work of the metallurgist is passing into the hands of the chemical engineer, a saying that results from confused thinking. Dr. Percy's definition that " metallurgy is the art of extracting metals from their ores and adapting them to various purposes of manufacture " still holds good, and those who extract the less common metals from their ores are also concerned with their industrial uses. The metallurgist was, in fact, a chemical engineer long before that title was invented, and the chemical engineer who works in the metallurgical field becomes, *ipso facto*, a metallurgist. When one considers the many important developments that have improved metallurgical practice during the past 50 years one is forced to the conclusion that the title " metallurgist " is one of which any technologist may well be proud.

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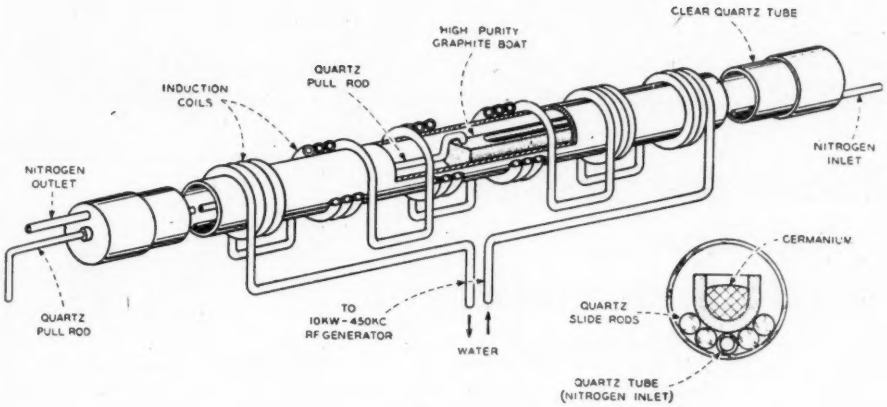

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Chrome and Titanium Activities of Farbenfabriken Bayer

John Grindrod, B.A.

A short account of mineral industry in Africa and Norway.

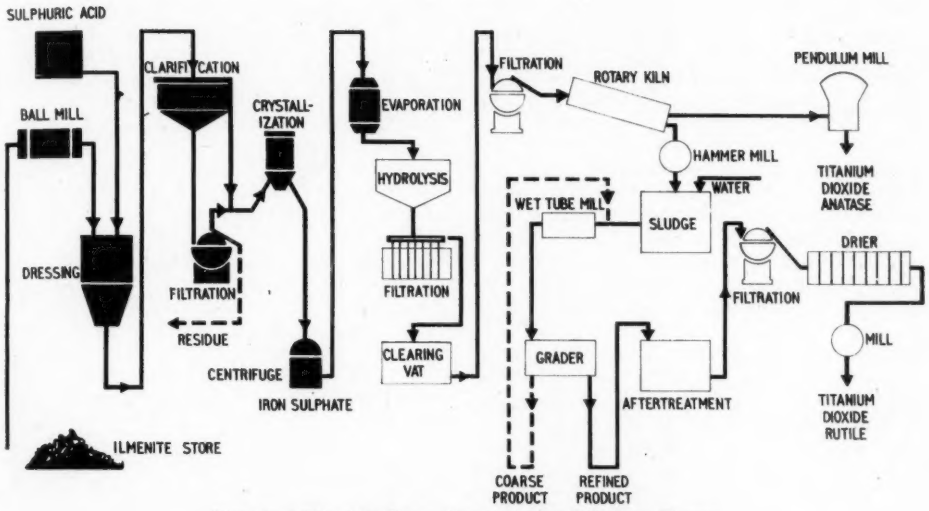
Chrome

During recent years the big West German chemical company Farbenfabriken Bayer A.G., whose main works at Leverkusen, near Cologne, were heavily damaged during the war, has made a rapid recovery. Production plants have been enlarged, new ones established, and new products have emerged from the research laboratories. In 1957 and 1958 particular attention was paid to the erection of new plants and no less sums than DM 313,600,000 and DM 309,100,000, respectively, were invested in the German factories alone, apart from overseas subsidiaries. Completely new chemical complexes grew up on the banks of the Rhine, where the company also built what is claimed to be Europe's most up-to-date titanium dioxide factory.

To meet the increasing needs of the company's chemical plants vast quantities of raw materials are required and one of such materials is the chrome ore used for a wide range of chrome products. Since the end of the 1920's this has been obtained by the Leverkusen and Uerdingen plants from South Africa and contains the chrome oxide used by Bayer, together with iron spinel. Frequently the ore contains magnesium and calcium instead of iron, or aluminium in place of chrome, thus reducing its value to the user. Normal ores from Africa contain up to 44% chrome oxide and are specially suited to chemical dressing, even if the needs of the chemical industry for this material are relatively small compared with the quantities of chrome ores used for making steel and fireproof bricks.

One of the largest known single deposits of chrome ore in the world is located on the Jagdlust farm, in Transvaal, of the late Dr. Hans Merensky, the well-known South African geologist. After Merensky's death in 1952 Jagdlust was purchased by an American industrial group, which acquired further deposits of chrome ore during subsequent years. These purchases, probably prompted by the fear of amalgamation moves on the part of the chrome-ore producers, led to similar efforts by Farbenfabriken Bayer A.G. Because of the immensity of the country and the distance of the chrome-ore mines to the port of shipment at Lourenço Marques, in Portuguese East Africa, which varies between 350 miles and 450 miles, it was considered important to find a mine with a suitable ore as near as possible to a railway station and with the shortest possible distance between that station and the port.

Between 1953 and 1956 several chrome-ore deposits were examined and finally a seam on the Rietfontein farm was located and acquired. This should be large enough, it is thought, to cover Bayer's needs for about 100 years at the existing level of requirements. The ore deposit there is specially suited to chemical dressing and lies within easy reach of the railway and with water available for mining and washing. Rustenburg Chrome Mines (Pty.), Ltd., Johannesburg, which was originally formed in 1938, is active here but at present the Bayer group is unable to meet all its requirements of chrome ore from the mine. However, as the preparation of pits and the erection of a dressing plant proceeds and now that the company has acquired an extended licence for the transport by rail of further quantities to the seaport the difficulties so far experienced are expected to be overcome by 1960. The South African railways are steadily developing and will be able to offer more wagons year by year.



Titanium Dioxide Flow-Sheet, Farbenfabriken Bayer.

The dressing plant at Rustenburg is being built by Bayer in collaboration with Klöckner-Humbolt-Deutz and a diesel power plant is providing electricity until the mains supply is available. At present about 220 natives are employed at the mine, but a far-reaching system of mechanization, both below ground and at the surface, is envisaged. By then, it is expected that the native payroll will have been reduced to 140 and the output per man-shift trebled.

Titanium

The production of titanium dioxide was recommenced by Bayer in the late autumn of 1957 at their new Uerdingen plant, from ilmenite shipped from Norway. Bayer, as part of I.G. Farbenindustrie, had previously produced titanium dioxide since 1927. At that time I.G. and the National Lead Company of New York pooled their knowledge in this field and formed the Titangesellschaft at Leverkusen on a 50 : 50 partnership basis. They co-operated well and successfully in the joint management of this firm until the Second World War put an end to it.

When, after the war, Bayer were able to start up again the company was under the control of the occupying powers. The Titangesellschaft had been separated from the company while, in the meantime, an anti-trust action by the American Courts had found the National Lead Company guilty of co-operation with other chemical firms and had ordered them to dissolve their titanium manufacturing associations either by selling their interests or acquiring those of the other partner. Thus the American firm bought up the I.G. interest in the Titangesellschaft.

As the market for titanium dioxide quickly grew and outpaced production Bayer, in spite of shortage of capital for the many other new buildings that the group had to erect, decided on the construction of a new titanium dioxide factory at Uerdingen. Despite the size of the new plant, which occupies 192,000 cu. metres of space on an 11,000 sq. metre site, its daily output of 40 tons to 50 tons is actually small in comparison with world consumption which, in 1958, was estimated by Bayer at 2,200 tons a day, excluding the output of the Communist states of the Eastern block. The plant was, however, planned for three times its initial capacity and some sections of the plant have already been completed. It is estimated that output will be 150 tons a day within a few years, or 7% of world production. In addition the plant has been designed so as to be very flexible with regard to variations of the qualities manufactured.

Produced in two forms, " anatase " and " rutile," the titanium dioxide undergoes after-treatment into a specially fine, high-grade pigment. On being received from Norway, the titanium ore, or ilmenite, is

transported by conveyor-belt from the store to large bunkers by way of ore mills. The ore is ground to a very fine powder in a ball-mill operated from a control room. Titanium dioxide and iron oxide of the ilmenite, mixed with sulphuric acid, are converted into sulphates at the dressing station and the titanium sulphate is then separated from impurities and the iron sulphate. The titanium sulphate solution is evaporated and afterwards boiled in a hydrolysis vessel to obtain the white hydrate of titanium dioxide. The titanium compound is separated from the solution by filters, the filtrate being clarified in large vessels. After the addition of mineralizers the titanium product is roasted at about 900° C. in a slowly-revolving rotary kiln 50 metres long. The finished titanium dioxide (anatase) is ground in a Raymond pendulum mill to a granular fineness of about 0·0003 mm. and packed in paper bags for dispatch.

The many different uses for titanium dioxide as a white pigment result from its special characteristics. It has an unusually high refractive index, so important for covering powder and tinctorial properties, high brightness values, resistance to light, atmospheric and chemical attack, and complete non-toxicity.

In Germany titanium dioxide consumption is divided approximately between : Lacquers and paints, 40% ; linoleum and oilcloth, 11% ; paper, 9% ; porcelain enamel, 8% ; textiles, 7% ; rubber goods and cables, 6·5% ; plastics and imitation leather, 6% ; welding electrodes, 3·5%, and various other industries, 9%.

Television Control of Kiln Operation

Closed-circuit control allows of visual observation in a cement kiln

D. LeClair[1]

Since the first rotary cement kiln was placed in operation in the United States in 1886 cement producers and equipment manufacturers have both been striving to change cement-making technology in order to improve product quality and increase efficiency. As a result cement kilns have progressed from vertical batch units to rotary horizontal kilns that operate continuously. Automatic operation can now be achieved in these kilns by instrumentation that controls draught, fuel input, and material flow.

Although these controls definitely improved kiln operation it was still necessary for the operator to inspect the interior of the kiln visually, which meant locating instruments and controls in the immediate area of the kiln firing hood. This arrangement hindered good plant layout and the efficient use of man power.

When the Ideal Cement Company's new plant at Houston, Texas, was being designed these problems were given full consideration. As a result there are two 12 ft. by 450 ft. "wet process" kilns in the new plant using natural gas for fuel (Fig. 1). All instruments and controls are in an air-conditioned room strategically situated so that all production and storage operations can be controlled from a central point. In addition, industrial closed-circuit television was incorporated to make possible efficient and continuous visual remote observation of the material and conditions within the burning zones of both kilns.

This system was developed in co-operation with design and application engineers at Diamond Power Specialty's Electronics Division in Lancaster, Ohio. Each kiln was provided with a complete closed-circuit system consisting of a camera, a power supply and control unit, and a monitor (Fig. 2).

The camera is a Model 300 "Utiliscope" equipped with a cold-cathode image-dissector type pick-up tube which has no filament, the

[1] Ideal Cement Co., Houston, Texas.

The material produced here appeared originally in *Rock Products* for March last.

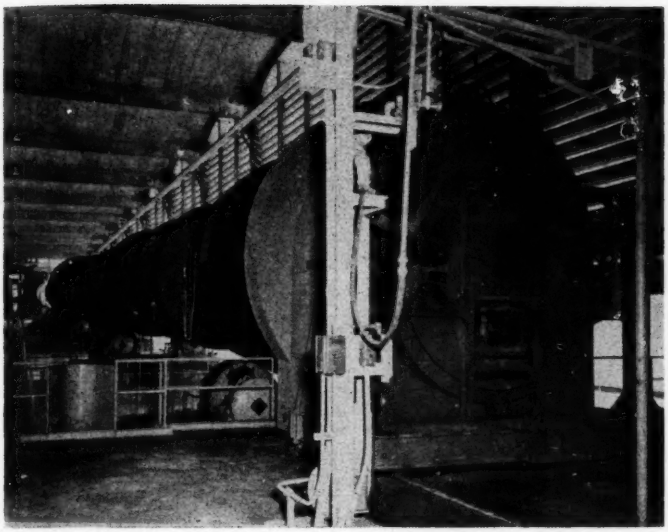


Fig. 1.— Close-up of Kiln :

Camera to Right.

tube resolution being 300 lines and designed for operation under difficult conditions. To provide efficient viewing the camera is mounted on a bracket-type platform attached to the kiln hood approximately three feet to the right and a foot below the burner line or axis of the kiln. Owing to the high ambient temperature, near 2,100° F., at the camera viewing port, it is equipped with an auxiliary source of cooling air.

This " Utiliport " window assembly consists of a heat-resisting Vycor glass plate covered with a special heat-reflecting coating and cooled by distributed air flow. Cool dry air at about 150 c.f.m. is introduced into the air chamber of the viewing port through a 3-in. inlet from a blower. At this point the air is circulated over both sides of the glass window and allowed to escape to the kiln interior. A portion of the cooling air is simultaneously diverted through a $\frac{3}{4}$-in. line to cool the entire camera. Compressed air provides a standby source.

A power supply and control unit for each camera is mounted in a cooler area approximately 40 ft. behind the cameras. All necessary camera controls are provided, including electrical focus and video gain and an automatic gain circuit compensating for any variations in light level. Once adjusted through the power supply and control unit the cameras require very few re-adjustments.

The monitors have 17-in. screens and are located in the air-conditioned central control room, 150 ft. behind the cameras (Fig. 4), being connected to the camera units by co-axial cables. By adjusting the monitor controls the operator can vary picture contrast, brilliance, focus, and horizontal and vertical synchronization. By placing both

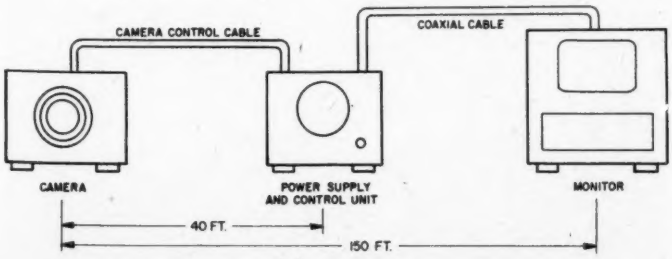


Fig. 2.— Diagram of Installation.

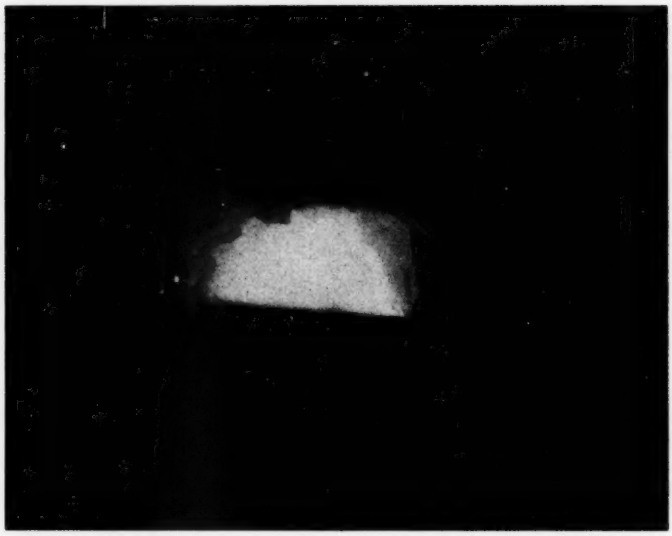


Fig. 3.— View of Clinker Forming in the Kiln.

television monitors in the centralized control room the operator is helped considerably.

The high degree of instrumentation aided by the visual observation by television has resulted in the production of a highly-uniform clinker. This is primarily due to the fact that the operator can now quickly adjust for correct flame characteristics and proper clinker formation and thus control the physical characteristics of the final product closely. Since the operator can scan the kiln interior from the " load line ", approximately 50 to 60 ft. from the firing end to the point of the clinker discharge, he can continually check the flow of slurry and the formation of the clinker (Fig. 4). Clinker ring formation can be observed and the operator can also quickly spot any local overheating by noting

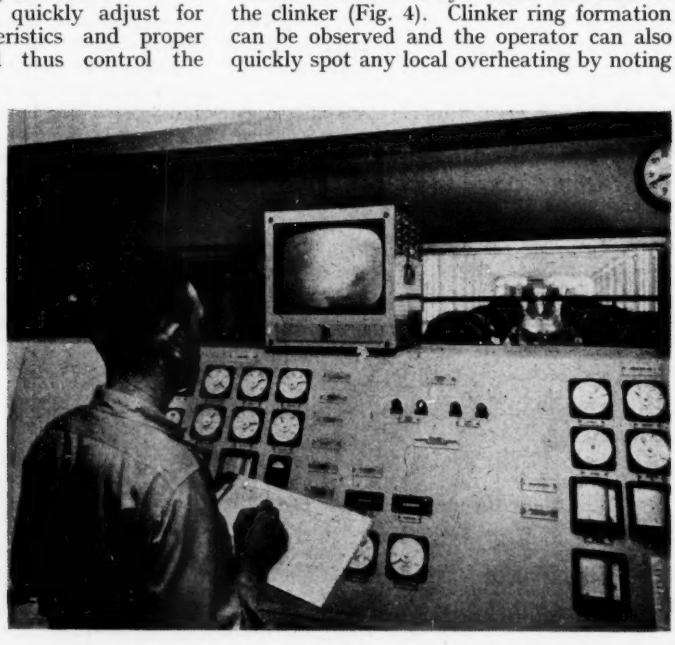


Fig. 4.— One of the Monitor Tubes.

the thickness of the coating forming on the refractory lining in the burning zone and by watching the size of the clinker as it falls.

The size of the material flowing toward the hood is also an indication of correct clinker formation. If the clinkers at this point are too large overheating is indicated; if they are too small it is possible that the slurry was not properly heated in the drying and the calcining zones. Continuous observation makes more precise control possible.

With a fully-centralized system to control the production process, assisted by closed-circuit television, the company operators have an extremely high degree of control of the basic variables influencing the production of uniform and acceptable clinker. Process improvement, it is believed, is an important weapon in the constant battle against rising costs and accordingly the use of full instrumentation and closed-circuit television is to be used on most new kilns being installed by the company. Also under investigation is the further application of remote observation by television in their plants.

A Nickel Centenary

A note on

Carl Langer,

Mond's collaborator.

M. Schofield, M.A., F.R.I.C.

Although in the histories of metals a few " trimmings " are often included in textbooks to lighten the tale, nickel outbids all others in striking yet authentic chapters which read like so much fiction. This point comes to mind with the centenary of the birth of Carl Langer, the collaborator with Mond in developing the Mond process for nickel extraction. Langer made his remarkable discovery of the reaction between nickel and carbon monoxide in a laboratory rigged up in some old stables at " The Poplars," Avenue Road, Regent's Park, a house where Mond centred his London activities. Here it was on that evening of October, 1889, that Langer was burning to waste some tail gases before going home for the night and noticed a peculiar luminosity in the flame from the gases in contact with nickel over a particular temperature range.

Nickel history illustrates how a chance observation, a " lucky accident " or smile from Dame Fortune, may change economic history—provided, as Pasteur reminded us, that such observations are followed up by painstaking research or experiment. Rather more than a century ago the surveyor Salter was sent by the Canadian Government to run a meridian-line north of Lake Huron. At a spot where later a Crown geologist found nickel ore on the site of one of the world's richest nickel deposits, Salter noticed his compass-needle stangely deflected 12° from normal; yet this hint was not followed up at the time. There was a second incident when Thomas Flanagan, a smith in a gang cutting a railroad for the Canadian Pacific company, noticed a peculiar vein of ore believed to be of copper. Later it was proved to be gossan rock with copper and nickel associated, the place being that where the Orford or Canadian Copper Company began a first smelting.

Then, again, to mention the name of Orford brings to mind how nickel, " the evil spirit in copper " to Saxony miners, was separated from its close associate in the second or alternative process to that of Mond. Just as Welsbach conjured his iron-cerium alloy for lighter " flints " after noting dumps of " useless " ceria left in a works yard, so did the Orford process come to light after a pot of metal on a dump had been found to have separated into two layers, an upper one of copper and iron suphides, a lower one containing nickel with little copper.

Carl Langer was an Austrian chemist who made his chance discovery in a laboratory before proving his practical prowess by supervising Mond's interests in the Sudbury mining activities and by building the great Clydach refinery to his own designs. He might have stayed a chemist, for, after research under the eminent Victor Meyer at

Zurich, he became chemist at a famous German aniline works, where he discovered an orange dye. Fortunately, Mond in 1885 was looking for an assistant, took a fancy to Langer, and brought him to London, with fruitful results from his choice. Mond in the eighteen-eighties was struggling with the ammonia-soda process, while in efforts to recover chlorine from by-product ammonium chloride had experienced trouble with some nickel valves. Since he used nickel oxide and china-clay pellets in an apparatus for converting hydrogen chloride to chlorine, he had thus two contacts with nickel in his applied chemistry. Then came the entry of carbon monoxide into Mond's researches, this being due to his interest in the gas-battery, " the dream of the electrochemist." Here he thought of substituting for pure hydrogen a form of producer gas containing hydrogen—but also containing carbon monoxide and possibly some hydrocarbons which ruined the absorptive power of Mond's platinum black electrodes.

There followed an inquiry into a possible reaction between carbon monoxide and nickel, the gas being generated from sodium formate and passed over fine nickel at 400° C. to convert the monoxide into carbon and carbon dioxide, it was hoped. It was from this series of experiments that Langer was burning his residual gases at the Poplars laboratory on that eventful evening when, at a point around 150° C. in the gas temperature, the flame became more luminous and remained so until the temperature finally fell below 100°. Langer applied heat to the glass delivery tube to see whether some form of Marsh's test for arsenic would explain the greenish-yellow flame coloration and indicate arsenic as impurity in the gases. Instead of the well-known arsenic stain on porcelain, as in Marsh's test, a bright nickel deposit was formed, a result which sent Langer to the classic work on nickel carbonyl and after three years gave birth to the Mond nickel process.

Mond and Langer built a pilot plant in a shed at the works of Henry Wiggin, of Smethwick, a firm noted for nickel alloys. Thence the Mond process was taken in 1899 to the Clydach refinery built under Langer's direction to convert nickel-copper matte. In " the Nickel Shed," as it was called, the Mond process was applied on a full scale for the first time, with Langer responsible for operating a difficult plant, for ensuring the whole being gas-tight, the temperatures within the large decomposers maintained constant, and the nickel shot kept in constant motion to prevent any caking together.

For 50 years the essential features in Langer's design were unchanged, so successful was this creation of his. Langer managed the Clydach plant until he retired—this in addition to his administrative work at Sudbury when Mond bought the nickel mine providing him with raw material. Langer's centenary of birth coincides with the 50th anniversary of Mond's death so that both men can now be commemorated.

Ore-Dressing Notes

(1) *Gravity Concentration.*

Dense-Media Separation

Several processes of the sink-float kind can be grouped under the general heading of dense-media separation, although the operating principles in each case may differ in important respects. Such differences may include : (*a*) Quiet single-bath separation, (*b*) controlled bath agitation, (*c*) series separations, (*d*) differential-density single-bath separation, (*e*) hydraulically expanded separating media, (*f*) autogenous media, and (*g*) centrifugal aid.

Since more than one of these principles is usually at work in a given system it is helpful to consider each in isolation, as an aid to its most effective use. Perhaps the simplest starting point is (*a*) above, in which (ignoring the slight increase of bath density between top and bottom, due to slow settlement of solid media) five spheres of equal diameter have been placed. If their specific gravities are respectively 2·0, 2·1, 2·2, 2·3, and 2·4 and that of the bath is 2·2, some accurate predictions as to their behaviour can be made, given the further condition that the bath is truly static, with no convection, streaming, vertical, turbulent, or other hydraulic sources of energy. Such a (hypothetical) bath would neutralize the potential energy of the 2·2 sphere. In the absence of frictional restraint the two lighter ones would rise and float, the lightest one being the first to reach the surface. Similarly, the two heavier ones would sink. Figuratively, then, the media

can be thought of as weighing each free-moving sphere which has been introduced into the fluid gently. Plunging feed would not only stir the bath but would also add the sphere's kinetic energy to the system.

If other conditions were stabilized, while the experiment was repeated with spheres of smaller diameters, the point would be reached where spheres 2·1 and 2·3 were almost stationary. This would be due to the pseudo-viscosity of the medium, which must be sheared through by a sphere moving up or down. When the sphere no longer has sufficient gravitational pull to start it travelling it acts as a middling.

It is thus clear that for a given viscous resistance there is a minimal limit to the size of the sphere which can move vertically. The term " pseudo-viscous " in this connexion is used to differentiate between this braking force and that of true viscosity, which is a function of molecular shear in a true fluid. The retarding force in a bath composed of a mixture of small particles of, say, ferro-silicon dispersed in water is mainly a function of its specific surface—that is, the total solid surface per unit (either unit weight or volume) of medium. This in its turn is determined by the screen analysis of these solid particles and by their shape. A secondary conditioning force, concerning which little appears to have been published, is the dispersive or coagulative tendency of the solids in the medium. The spheres are in effect " weighed " by the amount of medium each of them displaces and the out-of-balance amount provides whatever driving force each sphere can exert in order to shear its way through the medium.

The next point becomes clear—that the angularity, size-analysis, and (possibly) pH of the medium, are control factors in its pseudo-viscosity and therefore in the practicable retaining mesh of entering feed. If, instead of considering the movement of spheres, ordinary fragmental particles are considered, the third condition arises—*i.e.*, that the minimum size of particle capable of moving in a bath of given viscosity is determined by its shape. The main effect of shape is to develop a rubbing area at the surface, over which laminar flow of the medium proceeds when the particle moves. The minor secondary effect is that the particle cleaves its way and the disruptive work of cleaving is proportional to its presented cross-section.

Thus far consideration has been confined to a few particles. Continuing the concept of a completely quiet bath (despite the fact that floats and sinks must from now on be removed) discussion next turns to the continuously arriving stream of dry sized feed. Assuming that of 100 particles 45 will float, 45 will sink, and 10 will be equi-poised under given conditions, separation will begin with clear-cut delivery, but will deteriorate as the population of non-moving particles is increased. The sinking fraction finds increasing obstruction to its downward gravitation and the tendency will be for it to overflow as the bath chokes with middlings. It is therefore essential to handle the problem thus created, either by process control or by means of inbuilt features of design. In the case of quiet single-bath separation (*a*) the circulation of medium can be so divided between overflow and discharge *via* the bottom of the bath that the fastest-moving sinking fraction falls direct to the conveying system which drags it out, while the teetering fraction is drawn into a rising column and made to join the " sinks." In another form of bath the medium flows across, drifting the middlings to a separate submerged overflow. In both cases weir adjustment controls the transporting current and further movement can be pumped into the fluid system. In a third method the bath is formed on a troughed conveyor-belt, so that separate cuts at the discharge end can be made. These systems merge with (*b*), typified by the horizontal revolving drum into which feed is pressed with the aid of perforated plates mounted peripherally. The floats rise and overflow and the rest (sinks and middlings) are lifted as the plates rise and discharge their load into a delivery launder. If two such drums are mounted (*c*) coaxially in series, and medium of lower density is fed to the first, three products are made. A light product overflows from the first drum, which sends its sinks to the one containing a medium of higher density. From this second drum middlings overflow and true sinks are lifted to the discharge launder. With the drum system there can be no build-up of middlings since all submerged particles are discharged with each revolution.

Coming next to the differential-density method of operating (*d*) the solid fraction of the dense medium is so chosen as to have a consistent settling rate. It is circulated and withdrawn from overflow and underflow ports by displacement as new medium enters and is also mechanically stirred. Thus there is a graduated increase in opposition to fall

as the particle gravitates down from the lower density of medium at the top to the heavier at the bottom. The lower part of the bath is conical, so that the particle sinks into progressively smaller cross-sections of the pool of medium. This means that if new medium enters at a given depth and its outflow is split in controlled proportions between top and bottom discharge, the hydraulic upthrust can be weakened and the down drag increased by suitable adjustment of the horizon at which the fluid is introduced. This hydraulic effect helps to reduce the build-up of a mass of teetering particles. Should this occur the fact is indicated by a rise of level in the medium drainage sump. By periodically increasing the rate of down-draw the operator can relieve the bath of its middlings. If necessary they can be delivered to a diverting launder for separate treatment.

The next step away from the original " weighing " concept is the use of a hydraulically expanded quicksand or teeter bed (*e*). In coal treatment suitably-sized silica sands are expanded in a conical vessel, hydraulic water being introduced at various horizons. Three products can be delivered—float, middling, and sink. In the treatment of ores a suitably heavy-mineral sand flows along a shaking trough. It is kept in the required teetering expansion by hydraulic water introduced below. The ore is fed into this quicksand as it flows along the trough and the floating fraction is separated at the discharged end by a deflecting plate. This form of separator was developed in Sweden for the treatment of iron ores, using a tabled fraction of the ore to provide the quicksand. Autogenous media are also used in the more usual methods based on free settlement through a quiet bath.

E. J. P.

(2) *Dielectrics.*

Movement of Particles

For a number of years it has been known that when finely-ground minerals are suspended in a suitable liquid and subjected to the influence of alternating current they move in or out of the flux field between the electrodes in that liquid according to whether their dielectric constant is above or below that of the fluid. Apart from a minor application of this in separation of minerals for the purpose of microscopic work at a research and identifying level, application on an ore-dressing scale has been negative.

From time to time attempts have been made to utilize the fact that particles can be influenced in their direction by means of non-uniform fields, but thus far nothing appears to have emerged. Electricity influences the movement of nearly all particulate matter, but its action varies with the type of material. It acts not only on the charged particles but also on neutral ones and movement can be initiated either by a uniform or a non-uniform electric field. When there is no charge on the particle only a non-uniform field has any effect. This over the years has led to attempts to make electricity act as a kind of pump with no moving parts by using it as a non-uniform field. In one sense the dielectric constant numerically expresses the degree to which a given material is affected by such a field.

Work initiated both in the United States and in Germany during the recent war attempted to exploit the principles involved, but at that time failed. Since then certain interesting discoveries have been made by H. A. Pohl at Princetown. His work has reached the point where organic liquids can be made to fountain several feet in the air, liquid drops to hang or orbit around an electrode, and powders dispersed in benzene caused to flocculate or disperse. As one result a miniature electric pump, called by its inventor the isomotive cell, has now been made. It works on one-millionth of a watt, is the size of a man's finger, and handles one gram. of powder or liquid per minute. The mixture to be separated is fed on to a flat-bottomed trough inclined about 30° and slightly tilted sideways. Electrodes above and below the trough produce a non-uniform electric field which is adjusted so that one constituent of the feed moves to the higher side while the other gravitates and falls along the lower side. Separation is due to differences in dielectric constant which varies considerably from that of quartz sand (3·8) through to diamond (5·5), aluminium oxide (8·5), and zircon (12·5). The constants of possible separating liquids are 2·3 for carbon tetrachloride and 78·0 for water. The isomotive cell has been used successfully to separate abraded diamond waste from diamond-wheel cuttings and to remove zircon from rutile-zircon mixtures. It has also recovered silicon carbide from its mixture with aluminium oxide and has withdrawn zinc and iron from sand. These particulars are extracted from a note in the *New Scientist* for September 24, 1959 (John Lear).

Letter to the Editor

Radioactive Minerals in Nyasaland

Sir,—In the small debt action that I recently raised in these columns against Dr. Bosazza,[1] the latter claims that he has already settled the account. My plaint is that if he has paid up at all, he has done so at the wrong address. He certainly makes reference to prior work in Nyasaland carried out by geologists of the United Kingdom Atomic Energy Authority—but the Authority did not have a single geologist on its staff until well into 1956, some time after Dr. Bosazza's work at Tambane had already begun. The statement in my previous letter that the first identifications of the various radioactive minerals from the Tambane district were made from 1954 on by the Atomic Energy Division of the Geological Survey of Great Britain is correct in every particular. Omission of appropriate acknowledgment is the more surprising when we learn that mineralogical reports continued to be supplied by the Survey throughout 1956 and 1957.

But whether his debt is paid or not, there are some more interesting obscurities relating to these Tambane deposits which Dr. Bosazza should clear up. In one of his references to the deposits, he speaks of betafite " in crystals of about 203 cm. diameter " (*i.e.*, 6½ ft.) Do these prodigies really exist or are they but printer's errors? Certainly one cannot blame the printer for statements about " large boulders of uraninite," since these are mentioned more than once. Now, since all authorities agree that a boulder is not less than 20 cm. in diameter, a large boulder must surely be at least 40 cm. across. Such a mass of uraninite would be worth not less than £2,000. It seems very strange that these bonanzas were not recognized by Dr. Bosazza in the field until after the laboratory work was completed in South Africa. Can it be that, although he deplores Professor Ramdohr's use of the term *Gerölle* for silt-sized particles, his " large boulders " of uraninite belong to that same Lilliputian family as do the *Uranpecherz* " pebbles " of the Witwatersrand?

C. F. DAVIDSON.

ST. ANDREWS, SCOTLAND.

December 16, 1959.

[1] BOSAZZA, V. L., *Econ. Geol.*, v. 54, 1959, pp. 322–3; THE MINING MAGAZINE, v. 101, 1959, pp. 49–55, 326.
BOWIE, S. H. U., *ibid.*, p. 250.
DAVIDSON, C. F., *ibid.*, p. 179.

Book Reviews

Economics of the Mineral Industries : A series of articles by specialists. Edited by EDWARD H. ROBIE. Sponsored by the A.I.M.E. Seeley W. Mudd Memorial Fund. Cloth, octavo, xiv + 755 pages, illustrated. Price 90s. New York : American Institute of Mining, Metallurgical, and Petroleum Engineers.

This " special volume on mineral economics," published by the American Institute of Mining, Mettallurgical, and Petroleum Engineers and sponsored by the Seeley W. Mudd Memorial Fund as a special tribute to the founder of that Fund, a past-president of the Institute, takes the form of a symposium with a " foreword " by H. C. Hoover. To it 37 eminent authorities in the United States have made their contributions set out in eighteen chapters, several of these being subdivided into several parts. Beginning with an essay on the " significance of the mineral industries in the economy," the " distinctive features " of the industry are reviewed and then " mineral titles and tenure." There follow discussions on the " valuation of mineral property " and the " cost of acquiring and operating " such properties, in which all branches of the industry are considered, these chapters being followed by an account of mine financing procedures. The five parts of chapter 7 cover marketing, while succeeding sections cover questions of supply and demand and the specialized accounting methods suited to extractive industries. There follow chapters on taxation. " minerals in external and international affairs," " Government and regulation," " conservation and stabilization," and " labour-management relations " in North America. Chapter 15 reviews industrial research (" its aims, organization, and facilities ") and Chapter 16 " gold and silver—money and credit." There is finally a chapter on " nuclear energy " and another on " minerals in man's future." A comprehensive and authoritative work this, if ever there was one.

It is obvious that a book of this kind, sponsored and published in the United States, has often a decided American slant and a somewhat uneven mode of treatment. The subjects covered, however, are just those the mining men find treated somewhat cursorily in the ordinary text-book and the

book can, in this light, be heartily recommended to the profession.

The West German Economy: A Handy Guide to Facts and Figures. Cloth, pocket-size, 641 pages with 107 tables. Cologne: Deutsche Industrieinstitut.

The useful outline of the economic and social structure of West Germany, compiled by the staff of the Deutches Industrieinstitut, gives a concise yet comprehensive account of affairs in the Federal Republic. In it will be found information on the economic system and structure; characteristics of industry, trade, and agriculture; incomes, prices, and productivity; labour and social problems; currency, credits, and investments; standard of living; foreign trade, and party and trade union programmes. The pocket-book will be found of use to all having commercial dealings with West Germany.

☛ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Engineering Log

At a recent conference in Monaco the International Atomic Energy Agency discussed the problem of disposal of radioactive wastes. Russian scientists, it is evident, are concerned at the implications of their own findings that deep sea waters are not isolated but mix continuously and intensively. Extensive studies they have undertaken seem to show that there are layers of water down to a depth of seven miles in the oceans and that where such layers converge turbulence occurs, resulting in overall mixing. Soviet scientists have found indications of strong vertical currents of this type in the Black Sea. They are sometimes capable, it appears, of rising very rapidly and transporting material from the bottom of the sea to its surface. It is not surprising, therefore, that one of the Russian team at Geneva objected to any form of disposal of radioactive wastes which involves emptying them into the sea. Some scientists objected that no figures indicative of the time involved had been presented. Professor F. F. Koczy, of the Marine Laboratory of the University of Miami, commented that according to carbon-14 and radium measurements made the time span for total displacement of surface water by deep water, or the reverse, has been established at 400 years to 600 years for the Atlantic and at 1,500 years to 2,300 years for the Pacific Ocean.[1]

* * *

The difficulty of intelligent forecasting in connexion with long-term mining policy is grimly illustrated by the latest "Revised Plan for Coal" issued by the National Coal Board. The original document (1950) was amended in 1956 to an annual target of 240,000,000 tons by 1965, which was expected to prove inadequate. To-day the 1965 consumption is estimated as 200,000,000 tons to 215,000,000 tons, and already production exceeds this figure, although the full effect of the massive investment and reshaping of the industry has not yet been felt. Between now and 1965 the number of pits in operation are planned to fall from the original 950 to below 600. Manpower in 1959 was 626,000 and if consumer demand can be maintained at 215,000,000 tons it should fall to well below 600,000 by 1965. Meantime, despite revision of the £1,000,000,000 called for in the 1956 investment plan, which has been cut to £825,000,000, the N.C.B. will soon need more capital, apart from the financial problem presented by the tie-up of working capital in its unsold stock of 40,000,000 tons. Whatever may be said of the forecasts in the latest plan, it is glaringly the case that up to the present the Board has been consistently over-optimistic. Three-fifths of the nation's coal is consumed by a few large customers—notably, gas, electricity, steel, and the railways. It is evident that the public vote has been cast for oil, as the continuing fall of millions of tons annually in domestic consumption of coal bears witness. Coal must face the challenge and must stop dreaming of sales overseas. The industry will have to trim its capital development, cut down production, and reduce stockpiles. In other words, it must put its house in order, just as private industry would have to do in similar circumstances.

* * *

The largest radar antenna yet used will soon be built in Puerto Rico and used by United States scientists to study the surface of the planet Jupiter. The installation, which will be financed by the Department of Defense and used by Cornell University's new Center for Radiophysics and Space

[1] *Science News Letter*, Dec. 5, 1959.

Research, will include a 1,000-ft. receiving dish placed in a bowl of coral limestone provided by nature. Britain's Jodrell Bank radar unit, which leads in this field at present, by virtue of having made radar contact with Venus, is equipped with a radar antenna about one-fourth the size of the projected Puerto Rico unit. The new aerial is designed to reach across a distance of 400,000,000 miles, operating on a peak power of 2,500 kW and a frequency near 420 megacycles a second. The beam will be capable of sweeping 20° in each direction and able to retrieve signals sent to the moon, Venus, Mars, Mercury, and the sun ; it may reveal more about the earth's ionosphere in so doing than is known at the present time. In addition to the radar unit a transmitting station is planned for Cornell's campus and a radio receiving station south of Ithaca, New York, all as installations of the Center of Radiophysics and Space Research of the university. Dr. Thomas Gold, professor of astronomy, physics, and electrical engineering, will direct the new center.[1]

* * *

A Chicago firm which deals with heat-treating orders finds its time schedule particularly critical, since some 80% of all jobs coming into the company's shops on any one day have to be completed and returned to the customer on the next day. Customers are manufacturers of a wide range of products and need parts back quickly to complete assembly or processing. Any hold-up is costly and the cost of a delay in heat treating is reflected in all subsequent stages of the manufacturing process. To speed the work an air-powered wet-blast machine was introduced for cleaning. The unit is the Model 43 Liquamatte, made by the Techline Division of the Wheelabrator Corporation, Vicksburg, Michigan. The major part of the unit is contained in an enclosed metal cabinet about as tall as a man of average height, with an eye level observation window and below this two openings for the operator's arms. The openings are fitted with flexible gauntlets, permitting the use of the hands within the cabinet. Inside, the work is placed on a turntable moved by a car and a spray gun is provided for use by the operator's one hand, while he uses the other to spin the turntable so as to clean the work thoroughly from every angle. The machine is designed to take off heat scale, clean the surfaces of the work, for fine deburring, to blend grinding lines, and to finish dies and prepare surfaces for plating, as well as for general cleaning. The slurry spray which is used to clean is forced through the normal $\frac{7}{32}$-in. jet by air at 100 p.s.i. pressure at about 80 c.f.m. The compressor recommended for the purpose is a 20–25 h.p. unit. After spraying the slurry drops through a coarse mesh below the turntable and is pumped to a storage tank for re-use. The front of the cabinet is equipped with push-button controls and to the right of the enclosed cabinet is a partially-enclosed area used for rinsing.[1]

[1] *Science News Letter*, Dec. 5, 1959.

Bore-Hole Viewing

Illustrated here with its inventor Mr. Michal Krajčik, of Bratislava, is a television viewing device which has been used successfully in bore-holes up to 250 m. in depth. The pictures of the rock strata

produced by the camera in the nose of the probe are projected on to a screen in a special truck which accompanies the outfit. It is hoped soon to use the television probe to depths of up to 1,500 m.

[1] *Comp. Air Mag.*, Nov., 1959.

News Letters

BRITISH COLUMBIA

December 9.

Mineral Output.—The annual report of the Minister of Mines for British Columbia for 1958, issued late in November, discloses the actual value of production in the Province for 1958 at $146,875,081. The considerable decline from the $172,264,617 of 1957 was due to reduced prices for copper, lead, and zinc, and a reduced production of gold, silver, copper, coal, and several other commodities; increased output was recorded for iron ore, petroleum, and natural gas.

The quantity of lead exceeded the average of the preceding five years by about 2% and that of zinc exceeded the five-year average by 6%, but the combined value of the two metals was $12,600,000 below the average for the period. Copper output was reduced sharply as compared with that of recent years and while there was considerable change in the output of individual gold mines their combined output for 1958 was substantially the same as in 1957. However, in comparison with recent years, little gold was won from ores yielding one or more of the metals copper, lead, and zinc, as the main product; in 1957 such ores yielded about a sixth of the total gold. Silver output was reduced similarly, although at several mines silver recovery increased along with lead production. The value of the "principal metals" group declined by more than $18,000,000 from that of 1957.

Taxation.—The British Columbia Court of Revision has allowed a reduction of 30% in the 1958 and 1959 assessments of iron ore contained in six mineral claims of Texada Mines, Ltd. The 1958 assessment of $1,185,864 was reduced by $355,759 and the tax on the balance at 8% amounts to $66,408. Likewise the 1959 assessment of $1,730,654 was reduced to $1,211,458 and the tax levied thereon is $96,917. The appeal of Empire Development Co., Ltd., won a 50% reduction in the assessment of iron ore in its two producing claims on Vancouver Island. The Court found that the assessor should have allowed 20% for the cost of removal of overburden and stripping and that 30% would be a fair allowance for such other factors as location, operating period, labour problems, and winter shutdown. The assessed value of $1,543,663 was reduced to $777,831·50 and the tax calculated at 8% was $61,747. The 1959 assessment was cut from $912,252 to $456,126 and the tax set at $36,490. Both companies have filed notice of intention to appeal

Resources.—A feature of the 12th annual meeting of the British Columbia Resources Conference was the presentation of an evaluation of the mineral resources of Northern British Columbia by a select committee of geologists and mining engineers, including W. V. Smitheringale, W. R. Bacon, J. S. Scott, D. M. Cannon, Alexander Smith, and S. S. Holland. All have had extensive experience in the north, particularly in mineral exploration. The paper was read by C. M. Cambell, Jr., resident manager of Bralorne Pioneer Mines, Ltd.

A first consideration was to employ clearcut definitions of "mineral" and "ore." Reference to the former as "any inorganic substance having a definite chemical composition" was expanded to include materials of organic origin—such as coal, petroleum, and natural gas. Ore was accepted only as material from which one or more elements, metals, or minerals could be extracted at a profit. The use of such redundant phrases as "economic ore," "commercial ore," and "profitable ore," was deplored.

It was pointed out that in the 90 years in which prospecting and exploration has been conducted north of the Prince Rupert line of the Canadian National Railways only 11 lode mines had recorded profitable production and only one of these is now in operation. In its realistic appraisal the committee blamed lack of transport as a major cause for the modest exploration effort in the area. Only gold, with its high value-to-weight ratio, has been transported at a profit from the remote parts. The successful production of copper at Anyox and of precious and base metals at Premier and Tulsequah was due to the proximity of the mines to tidewater, while the lead-silver-tungsten output at Hazelton, coal at Smithers, and mercury at Pinchi Lake was from points adjacent to rail transport. Construction of the Alaska Highway facilitated the development of the Cassiar asbestos deposit. It was not claimed that better access would "automatically unlock a vast storehouse of undiscovered mineral wealth," but the committee did believe that it would provide an incentive in the search.

For the purpose of assessment the committee divided Northern British Columbia arbitrarily into five parts. The *Coast Mountain* division has a recorded production of lode and placer gold, silver, and base metals valued at $263,072,513; the potential for new mine development is considered fair to good. The *Hazelton-Omineca* division has produced metals to a value of $33,647,333; about 30% of the area is underlain by igneous rocks and the potential is fair to good. The *Cassiar-Teslin* division has produced placer gold to a value of $1,245,186, lode gold to $6,312, and asbestos to $24,064,298; although 40% of the area is underlain by igneous rocks the potential is regarded only as fair, because of irregular and limited surface indications of mineralization and because of the relative inaccessibility. The *Central Skeena* division has a poor potential for metals and only slightly better for coal or petroleum deposition. The *Northern Rocky Mountain Foothills and Interior Plains* division has a good potential for coal and petroleum.

At the present time there is in Northern British Columbia one major mining operation, that of the Cassiar Asbestos Corporation. The Granduc copper property is considered potentially important but dependent on copper markets and suitable transport facilities. The Tulsequah mines have produced important quantities of gold and base metals and could do so again under favourable operating conditions. Prospecting possibilities are good in the areas adjacent to the former producing mines. The Letain asbestos prospect is interesting but yet to be evaluated.

To the end of 1957 Northern British Columbia's production of minerals, exclusive of coal, petroleum, and structural materials, was valued at $322,000,000. Dividends paid to shareholders of the various operating companies aggregated $37,000,000. Apart from the vast sums spent initially on exploration and development of the productive mines only $25,000,000 has been expended on exploration and prospecting in the past 20 years.

The report concludes: "It should be clear that

the benefits of mineral development remain within the country in the form of payrolls, purchase of supplies, and taxes, and that it is in our interests to see that mineral explorations is encouraged."

Nicola.—Formal notice of intention to proceed with the second phase of development of the Craigmont mine has been received by Craigmont Mines, Ltd., from the operating group, consisting of Canadian Exploration, Ltd., Noranda Mines, Ltd., and the Peerless Oil and Gas Co. The earlier agreement of June 1, 1958, required work performance to a minimum value of $500,000 within 18 months. By the terms of the notice of November 27, 1959, the operators are now obliged to expend not less than $500,000 within the following 18 months during which time they must agree on production plans or abandon the property. The Craigmont company is to receive $600,000 and the operators are to be re-imbursed for all pre-production expense out of first profits, after which the division will be 40% to Craigmont and the balance to the operating group. The mine is considered certain of production, but the scale of operation remains to be determined.

Greenwood.—Consolidated Woodgreen Mines, Ltd., is continuing to mill 650 tons of ore daily and plans to increase the rate to 750 tons. The latter figure is considered the limit achievable with one shift on the crushing plant and is, therefore, considered economically advantageous at the present time. The mill has a rated capacity of 1,000 tons and has treated up to 1,100 tons in 24 hours. Average heads are between 0·9% and 1% copper. The strike of employees of the Tacoma smelter has had a restricting effect on the Woodgreen operation inasmuch as the stockpiling of concentrate has become a problem and the operator is in need of the 25% of payment being withheld until the strike is settled. The Consolidated Woodgreen company reports extensive reserves in two ore blocks within half a mile of the mill. The ore grades slightly better than 1% copper and is entirely recoverable in open-pit mining.

Continental Consolidated Mines, Ltd., has equipped the Brooklyn-Stemwinder mine at Phoenix with storage and withdrawal bins and is carrying on mining concurrently with exploration and development. The ore will be shipped to one of the concentrators in the vicinity for custom treatment. At the present time none of these cares to accept delivery owing to the bottleneck caused by the Tacoma smelter strike.

Camp McKinney Gold Mines, Ltd., is to start shipment of high-grade gold ore and lower-grade fluxing material to the Frail smelter before the end of 1959. The former No. 2 shaft, which extended from the 4 to the 6 level, has been extended upwards to surface by raising and slashing and is now equipped with two compartments and manway. Three ore-shoots are being prepared for stoping and recent sampling has disclosed one of these to be very rich, with assays of more than 10 oz. of gold per ton over a width of 22 in. It is planned to ship 50 tons of ore daily and when in organized operation it is expected this goal can be achieved with a crew of 12 men. Situated only eight miles from railway at Rock Creek the company does not maintain any camp owing to the accommodation available at that point.

Cariboo.—The Cariboo Gold Quartz Mining Co., Ltd., has met with encouraging results of exploration and development in the Burnett zone. This zone was a fortuitous discovery, since it was found in the course of the long 3,000-ft. level drive to the Mosquito Creek fault at a point yet 1,000 ft. short of the objective. Replacement ore grading in excess of 1 oz. of gold per ton was found and some stopes were immediately established. Drill holes were fanned out in all directions and numerous intersections of more replacement ore were obtained both above and below the level. Since the discovery was made 1,600 ft. below surface and there are outcrops on surface in the vicinity the company is hopeful of an impressive vertical range for the favourable zone.

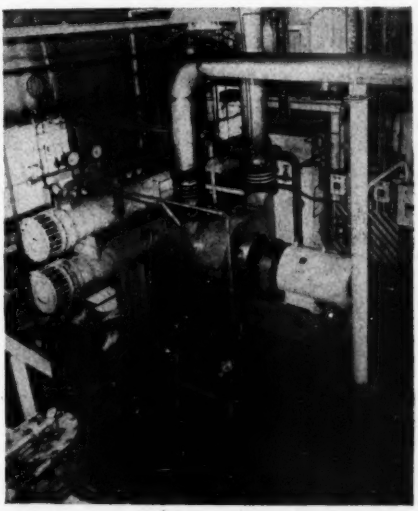
Lillooet.—Bralorne Pioneer Mines, Ltd., has obtained an option to acquire a 60% interest in properties owned by Ace Mining, Ltd., in the valley of the Bridge River, between Minto and Wayside. The properties include the Congress mine, on which a very considerable amount of underground development has been performed.

EASTERN CANADA

December 24.

Gold Production.—The output of the gold mines of Ontario for October last included 227,192 oz. of gold and 34,733 oz. of silver, valued at $7,558,567, from 794,030 tons of ore milled. In the period there were 30 mines operating, the average grade of ore being $9·52 per ton and the number of workers employed 11,006.

Sudbury.—It has now been announced by the Texas Gulf Sulphur Company and the International Nickel Co. of Canada that encouraging results have been obtained in the initial eight-months operation of a pilot plant for obtaining pure sulphur from sulphur dioxide in the high-quality roaster off-gas at Inco's large iron-ore recovery operation. The feasibility of large tonnage commercial production is



Sulphur Recovery Plant.

to be determined in part by costs as projected from further pilot operations and the future price of sulphur. It is revealed that the plant was completed last year and with its associated facilities cost over $500,000. Since April operations have been continuous and will be continued on this basis in an attempt to conclude the development programme successfully. In the event sulphuric acid and liquid sulphur dioxide are now being produced in quantity from Inco smelter gases. In the process the sulphur is extracted by reacting high-quality sulphurous gas with a chemical reducing agent at high temperature over a specially-developed catalyst. Among the three satisfactory reducing agents natural gas (now available at Copper Cliff) has some technical advantage over propane gas or fuel oil, but selection will remain flexible in the light of cost. The accompanying photograph shows a part of the plant in operation.

North-Western Ontario.—The Department of Mines has announced that an aeromagnetic map of the West Red Lake Sheet has been released. The sheet is at a scale of 1 in. to 1 mile and covers an area approximately 400 sq. miles west of Longitude 94° W., and includes the townships of Ball, Todd, Mulcahy, and Killala.

Arrangements have been concluded between the Nickel Mining and Smelting Company and Faraday Uranium Mines, it is stated, for financing the development of the first-named company's nickel prospect in the Kanora district. The scale of operations remains to be decided.

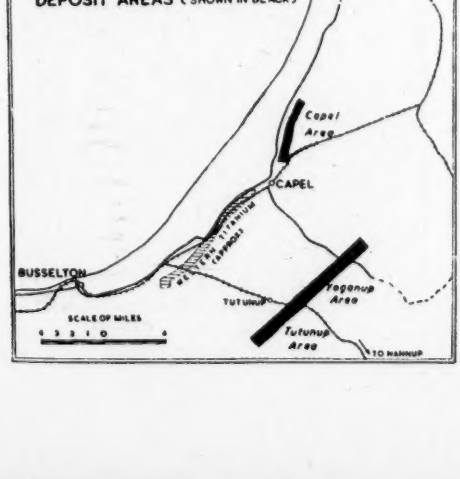
Milliken Lake.—Plans for expanding the mill at Milliken Uranium Mines have now been finalized, it is believed. A change over to pebble milling is envisaged.

Manitoba.—It is estimated that the Thompson mine of the International Nickel Co. of Canada should reach full production in 1951. Lying 400 miles north of Winnipeg the plant will have an initial production capacity of 75,000,000 lb. of nickel a year. The 6,000-ton per day concentrator should start work in May and the smelter in July.

Quebec.—The Quebec Iron and Titanium Corporation expects to be operating at capacity in the coming year, it is announced. At present about 20,000 tons of pig-iron and 25,000 tons of titanium slag are produced from the ore being mined at Allard Lake.

In the year to June 30 last Campbell Chibougamau Mines made a profit of $433,209, as against a loss of $1,248,541 for the previous year. At the end of the financial year the proved ore reserves were estimated as 2,062,790 tons averaging 2·37% copper and 0·075 oz. of gold per ton. Probable reserves are given as 8,128,343 tons grading 2·54% copper with 0·068 oz. of gold per ton. The output for the year included 25,132,950 lb. of copper, 29,854 oz. of gold, and 198,245 oz. of silver.

Work from the 850-ft. level at Malartic Mines has resulted in the discovery of a new ore lens averaging $10 per ton in gold over a width of 7·7 ft.

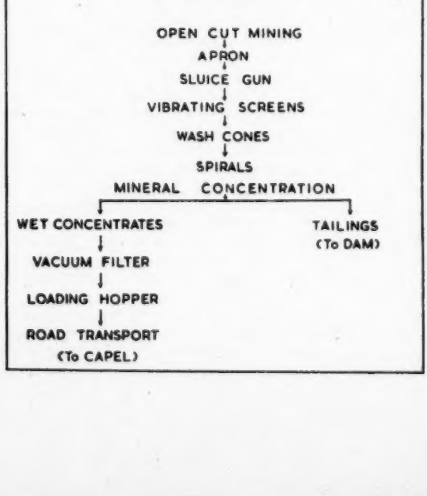


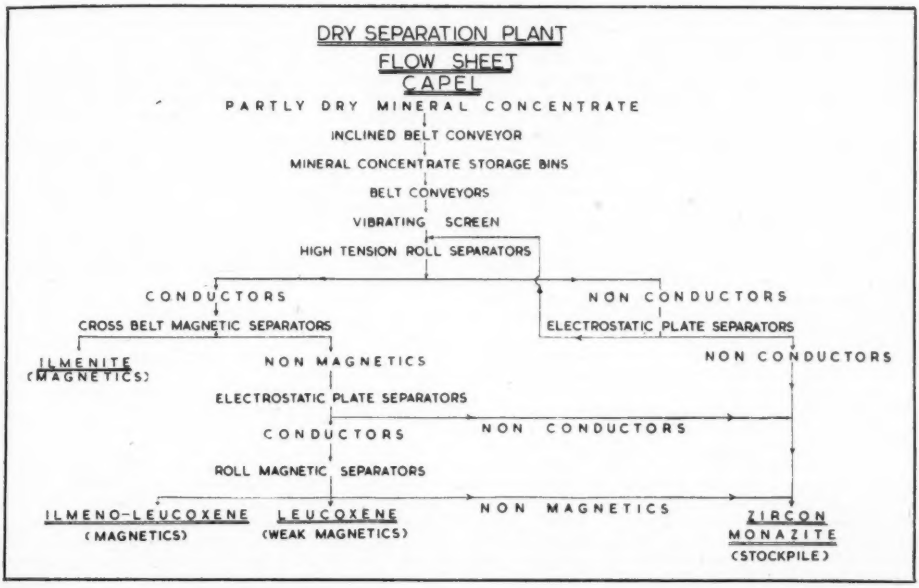
WESTERN AUSTRALIA

December 3.

Beach Sands.—For the year ended June 30 last the Western Australian production of ilmenite, monazite, leucoxene, rutile, and zircon has been worth nearly £A440,000, but the tempo of production has been slowed in recent months. In spite of this Westralian Oil, Ltd., which has installed plants for mineral concentration at Yoganup and for mineral separation at Capel, appear to regard the future possibilities favourably. The plants are almost complete and it would appear that preparation of good-grade concentrates will soon be possible.

For the present it is proposed to stockpile the zircon and monazite sections and to give chief attention to the ilmenite and leucoxene recovery. Yoganup ilmenite runs 60% TiO_2, while the leucoxene runs at 80%—a very high-grade material. The plant is capable of dealing with 100,000 tons of minerals per year, yielding 60,000 tons of ilmenite,





11,000 tons of leuxocene and 6,000 tons of ilmeno-leucoxene (72%); 13,000 tons of monazite and zircon make up the remainder. The plant is to run only at half capacity for a time.

Iron and Manganese Ores.—For many years past various interests in Western Australia, as well as the Governments, have attempted to do something towards exploiting the large reserves of both iron ore and manganese ore in the State. The situation at present is that the large Yampi iron-ore deposit has been yielding about 500,000 tons of ore per year for use in the iron smelters of the Eastern States and that an amount of ore from the deposit at Koolyanobbin (near Southern Cross), amounting to about 30,000 to 40,000 tons per year, has been used at Wundowie to make charcoal iron. A large quantity of manganese ore has been exported to various terminals.

Throughout the years the Federal Government has exercised a very restraining control on production and exploitation for any form of export. In some quarters it has been realized that the amounts of both materials available are large and year by year the quantity seems to grow. It now seems evident that there should be a considerable tonnage available for export without jeopardizing the position with respect to Australian requirements in the foreseeable future.

Some months ago the present Government in Western Australia stated its intention of advertizing for tenders for the purchase and production of iron ore, laying some emphasis on the deposits at Koolyanobbin and at Mount Goldsworthy (near Port Hedland); the tenders were to close on November 30. It now appears that a number of firm offers, with substantial backings, have been made and consideration is at present being given to them.

In the past few weeks there has been a considerable amount of activity in the Port Hedland areas of Mount Goldsworthy and Ripon Hills, the former being mentioned for iron ore, the latter for manganese ore. If exploited the natural port would be Port Hedland, from which a very considerable amount of manganese ore has been shipped already; it grades about 48–49% Mn.

Yampi ore is worked by Broken Hill interests and the ore runs about 63–64% iron.

No figures can be quoted for the possible ore that may be produced from Mount Goldsworthy. The distance to Port Hedland is about 60 miles, while the Ripon Hills areas are about 150 miles.

The Koolyanobbin areas have been visited recently by Japanese interests, who describe the deposits as the biggest they have ever seen. Sir Arthur Fadden (Treasurer in the Federal Parliament for many years) represents other interests in the iron-ore matter, and is believed to have tendered. No note has been made of another large iron-ore deposit at Tallering Peak and only brief mention has been made of deposits at Wilgie Mia, near Cue, and at Mount Gould. It had been the intention of the Government to deal with the Koolyanobbin deposit on the basis of about 500,000 tons per year, with reserves up to 5,000,000 tons and the Mount Goldsworthy reserves up to 10,000,000 tons.

AUSTRALIA

December 21.

Oil and Gas.—Interest in the oil and gas search in Australia has been stimulated by a heavy flow of gas at the well of the Australian Oil and Gas

Corporation in the Camden-Penrith district of New South Wales. The flow is reported to be at the rate of 500,000 cu. ft. per day at a pressure of 600 lb. per sq. in. from a depth of 1,741 ft. in sandstone. A previous bore, No. 7, gave gas at the rate of 1,000,000 cu. ft. per day with a pressure of 415 lb. per sq. in. These results indicate the prospect of supplying gas in commercial quantity to the industries of Sydney and are the first strong encouragement in a long period of prospecting.

The most recent development of note is at the exploration well at Port Campbell, Victoria, being drilled by Interstate Oil, the partners in which are from Broken Hill Pty., Vacuum Oil Co., and B.P. Exploration. Investigations by Interstate have extended over about six years and have directed operations to the Port Campbell locality, 120 miles west of Melbourne. Drilling has reached a depth of 5,695 ft. ; a strong showing of gas has been met and formation tests are being carried out to evaluate its significance. The gas is reported to have a petroliferous composition and analysis shows hydrocarbons in the ethane-pentane range. The strata being penetrated are Jurassic and comprise sandstones, mudstones, and some coal.

The chairman of Oil Search, Ltd., has now said that there appears little prospect of commercial oil at Bwata, Papua, where several gas showings have been passed through. Four bores—at Kuru, Barikewa, Puri, and Bwata—have all met hydrocarbons in varying quantity. This evidence has strengthened the view that commercial oil exists and will eventually be found. Geological investigation has suggested the best prospects are in Mesozoic sands north-west of Barikewa. Several considerable anticlinal structures are known in this region. The company has received a subsidy of £A250,000 from the Commonwealth Government, and application has been made for a further subsidy of £A294,000 to cover recent seismic work. It is considered that the gas met in substantial quantities in the Barikewa and Kuru wells remains a potential asset. Despite substantial and increased Commonwealth aid to oil search, it is being urged in some quarters that this is inadequate and should be increased and a 50 : 50 basis has been suggested for drilling to 2,000 ft. and then on a graduated scale at the rate of 10% for each 1,000 ft.

Tennant Creek.—Gold output at Tennant Creek is being well maintained by the Australian Development Company and the gold-copper Peko Mine. Although Australian Development has so far failed to locate payable gold below a depth of 315 ft. lateral development has more than maintained ore reserves ahead of annual mill requirements. Ore reserves are at present estimated at 158,000 tons of positive ore, equivalent to a life of 4½ years, and the company hopes to maintain this position. The grade of reserves is 26·8 dwt. gold. In addition there are two years' supply of sands stockpiled at the mine. Diamond drilling is being continued, as well as examination of outside occurrences.

The Peko gold-copper mine has been opened up to the 1,000-ft. level, but transport charges from mine to smelter of about £A100 per ton of copper are a heavy handicap. The company is cross-cutting for the lode at the Orlando mine, eight miles distant. There diamond drilling indicated a lode varying in value from 1 oz. to 4 oz. at a depth of 400 ft. and a three-compartment shaft has been sunk to that depth, from which cross-cutting is now in progress.

The results obtained by drilling by this company have led to the commencement of diamond drilling on a lease five miles to the north, where the geological features accord with those associated with gold occurrence on the field generally and are of an encouraging nature. The area is puzzling geologically and, therefore, difficult to interpret and prospect. These facts, and the great importance to the Northern Territory of gold production, have inspired the chairman of Australian Development N.L., to suggest that the Commonwealth Government should give more encouragement to prospecting. In the coming year the company will have the advice of Professor Rudd, Professor of Economic Geology in the University of Adelaide.

Mount Lyell.—Mount Lyell Mining and Railway in Tasmania is to commence a major operation of a nature that has not been undertaken on the West Coast copper field for 50 years. A contract has been let to Utah (Aust.), Ltd., for the removal of 2,000,000 tons of overburden from the Mount Lyell open-cut workings. Machinery for the work is now being delivered at the port of Strahan, but its transport to the mine will present difficulties because of the tortuous nature of the route and the size and weight of the equipment. Much of this will be sectionalized and re-assembled at the mine workshops. The company's mining programme has called for an increase in the rate of overburden removal for several years to come and it has been considered more expedient to have this work done by outside contract than to carry it out as a company operation. The work is expected to take two years. The company has increased its capital by £A1,162,500, but does not expect any immediate substantial increase in earning capacity. A part of this capital will be used in the cost of the new crushing station plant and machinery ; in prospecting, in conjunction with Electrolytic Zinc Co., of Australasia, of the Moore Valley area in the south-west of Tasmania, where indications of mineral occurrence on a reasonable scale are encouraging ; in payment for shares in Renison Associated Tin Mine, in which the Lyell company now has a controlling interest and where it is carrying out exploratory work ; in the removal of overburden from the West Lyell ore-bodies, and for testing the Crown Lyell No. 2 ore-body. West Lyell ore-bodies are now more clearly defined because the open-cut has reached greater depths and accelerated removal of overburden will increase the production of copper. The Crown Lyell No. 2 ore-body is a possible source of high-grade ore. Indications are that further prospecting of the Renison field and rehabilitation and extension of the milling plant warrant the capital required for this enterprise.

Western Australian Coal.—There is anxiety about the future of coal mining in this State and the opinion has been expressed that if there is not an immediate increase of production from mechanized mines on the Collie coalfield by Amalgamated Collieries, Ltd., the company will be forced to close its mines. This information has been given to employees and a conference is being held between the parties. The mechanical equipment is of a high order, but it may be inferred that it is not being used to capacity. Output has fallen at the rate of 2,000 tons of coal per fortnight and because of this the cost of production exceeds the price which the company is receiving. This state of affairs opens the way for serious inroads by fuel oil from the Kwinana refinery which can supply all the requirements of the State Electricity Commission at a price substantially

below that of Collie coal. This trouble seems to be following the path of past history on the New South Wales coalfields, which threatened to wreck the industry, until wiser councils prevailed.

Broken Hill Proprietary.—This company is entering the search for minerals in Tasmania. Directions of interest will be search for iron ore, particularly ore with manganese content for possible use in the company's Bell Bay project, which is the establishment of an electro-metallurgical industry or industries in the neighbourhood of the works of Australian Aluminium Commission. A prospecting licence has been granted to the company for search within the State for possible raw materials for the electric furnaces of the ferro-alloy plant.

Bauxite.—A trial shipment of bauxite from Western Australia has been made from Fremantle to the Australian Aluminium Commission at Bell Bay, Tasmania. At present the Commission obtains all its supplies from India, Malaya, and Indonesia, but if the Western Australian trial shipment proves satisfactory, and similar ore can be delivered at a favourable price, a useful industry could be developed. The Commission's requirements of bauxite are 52,000 tons per year. Bauxite is being mined by Western Aluminium N.L. on leases in the Darling Ranges.

Gold Discovery.—A discovery of gold, stated by the Chief Government Geologist of Victoria to be one of the best in the past 15 years, has been made at Wedderburn, the locality of a famous early days alluvial field. Some 10 years ago nuggets totalling 300 oz. of gold were found in the township. The present discovery is a narrow, but very rich, quartz vein., which returned 28 oz. of gold from 23 tons of quartz. In the present depressed state of gold mining in Victoria the discovery is interesting and may stimulate prospecting.

Uranium in New Zealand.—There has been steady prospecting for uranium on the West Coast of the South Island, the main centre being the Buller Gorge, where uranium occurrences are fairly widespread. Areas have been held and prospected by Buller Uranium, Ltd., but although small quantities of pitchblende have been found from time to time there has been no discovery of any importance. The latest discovery is to be examined by the Geological Survey and the economic importance of the find has yet to be proved. The discovery consists of streaks and lumps of mineral in radioactive grit and conglomerate. It is hoped that the recent find will stimulate prospecting in the locality where radioactivity is stated to be fairly widespread.

FAR EAST

December 9.

Malaya.—The tin-mining industry has naturally welcomed the decision to increase quotas during the next period of the International Tin Agreement. As a result Malaya will be able to export 13,590 tons from January to March, 1960, against 11,838 tons in the previous quarter. The president of the F.M.S. Chamber of Mines, speaking in Ipoh said: "All miners will welcome the further approach to conditions of normal production," but warned the industry that "the situation is not easy to assess at present, and will not be until the dispute which caused the U.S. steel strike, at present in suspension, is settled." Mr. Woo Ka Lim, secretary of the Perak Chinese Mining Association, also welcoming the increase, said Chinese miners would need time to make arrangements since those who wanted to start up operations would either have to unwater their mines or set up operations on new sites.

The number of active tin mines in Malaya increased to 455 in October last—a record for 1959—22 mines re-opening in the month. Seven more dredges also started up in October, to make the total 42, and the number of people employed in tin mines increased by 401 to 22,132.

Malaya's production of tin metal in October totalled 3,478 tons, 439 tons more than in September, bringing production in the first 10 months of 1959 to 29,559 tons.

Chinese miners in Malaya have protested to Mr. Tan Siew Sin, Minister of Finance, about an increase in tax on imported fuel oil. Most Chinese miners use diesel engines and they have been paying about 63 cents for a gallon of diesel oil; the price with the new tax is brought up to some 83 cents.

Thailand.—A 2,500-ton sea dredge, claimed to be the only one of its kind in the world, is, at the time of writing, in Penang harbour, Malaya, waiting to be towed to Puket island. Reconstructed from an old land dredge, it is to be used by Tongkah Harbour Tin Dredging. Powered by German diesel engines, its dredging capacity is between 250,000 and 300,000 cu. yd. of tin-bearing ground a month. The dredge has a bucket ladder 140 ft. long capable of digging to a depth of 100 ft. Preparatory work was done on this dredge in Malaya at the mouth of the Juru River.

Mr. Nai Vicha Sethabut, Director-General of the Mines Department, is reported in Bangkok, Thailand, to have said that a joint Thai-foreign company, known as the Oawa Khan Tin Company, was also attempting to mine tin ore from the sea off Puket. The total capital of the firm is given as (Malayan) $1,980,000. The Thai Government had 35% interest in the company and private Thai citizens 12%. The remaining shares are held by British and Malayan interests.

In a move to encourage industrial development the Thai Government plans a gypsum industry capable of producing a minimum of 5,000 tons of mineral and 500 tons of finished gypsum products a year. To encourage foreign investors to take part in schemes of this nature the Bank of Thailand has announced that special facilities will be extended to them, particularly when they wish to remit dividends, profits, interest, capital, or principal to their home countries.

Burma.—Japanese interests have been seeking iron-ore prospecting rights on Pigeon island, in the Tenassarim area of Burma, near the Thai border. At the same time negotiations have also been going on between the Burmese Government and Japanese interests regarding a joint venture to prospect for oil in the same district.

Ceylon.—Russian experts recently arrived in Ceylon, it is reported, to select a site for a big iron and steel project which will be financed from a loan granted by Russia. In the first stage a steel rolling mill is to be built and subsidiary industries set up to make wire products. In the second stage steel melting furnaces are to be provided to melt all available local scrap, supplemented if necessary with imported pig iron.

Pakistan.—Iron ore found in the Waziristan area is of high grade according to the Pakistan Industrial Development Corporation and plans have been made to exploit the ore. A plan for the re-organization of the coal-mining industry in West Pakistan at a cost of Rs. 70,000,000 has been prepared by the Development Corporation. The Sor Range in Baluchistan alone is supposed to have 1,600 sq. miles of coal-bearing beds containing 500,000,000 tons of coal. At present Pakistan consumes about 2,200,000 tons of coal annually, of which, 1,500,000 tons is imported.,

India.—Australia has arranged to train more Indian steel engineers under the Colombo Plan. An Australian Government source recently said that in view of the success of past training a third party of 24 engineers had been accepted. During their 12 months' training members of the group would be attached to the Broken Hill Pty. steelworks at Port Kembla and Newcastle and would receive training and experience in many aspects of the steel industry.

SOUTHERN AFRICA

December 24.

General.—Progress and development along the mining and industrialized belt of the Southern Transvaal are manifested in two well-defined directions. Industrial haze and smog conditions are spreading, while another sign more recently has become evident in the form of a State-appointed Commission to investigate and report on ionizing radiation. This may be one of the preliminaries to ushering in the atomic age in South Africa, apart from the actual production of uranium oxide. The Commission will report on the dangers of exposure to X-rays or any other ionizing rays not yet controlled by legislation and on the uses, misuses, and abuses of such radiation ; the quantity of radiation to which individuals in various capacities are exposed ; attendant health and other hazards to which personnel and the general public are exposed ; various permissible doses of radiation, and any related matter deemed necessary.

The S.A. Carbide and By-Products Co., Ltd., has effected economies in production costs through re-organization and reconditioning of plant and has thereby been enabled to enter new markets under conditions of severe price competition. Increased demand has been reflected in sharply higher carbide sales. Production was recently interrupted by a major breakdown in the company's power station which has been repaired.

Transvaal.—The capital cost of the programme of S.A. Land and Exploration Co., Ltd., to provide a new shaft system to open up the Withok section, advance a certain footage of development, and expand the underground pumping capacity to cope with a greater inflow of water as neighbouring mines are closed down, will amount to about £300,000. The new workings will be served by the vertical component of the proposed new shaft to be sunk to a depth of about 4,260 ft. The deeper zone south of the fault will be served by a sub-vertical ventilation and hoisting component sunk from about 4,260 ft. to 7,350 ft. The new shaft site has been reached by cross-cuts from existing workings in the Sallies section, from which cross-cuts limited exploratory development has been effected with encouraging results.

Headframe, No. 3 Shaft, President Steyn.

The most important aspect of the present drilling programme of West Witwatersrand Areas concerns the extension of the Ventersdorp Contact Reef south and east of the Libanon mine, for which purpose two bore-holes are being drilled, and to the west, the extension south-west from the Doornfontein mine of the Carbon Leader Reef, for which purpose two other bore-holes are being drilled. Further westwards another drill is turning quietly in difficult ground, in an area where results to date have not been particularly outstanding but doubtless have given information of geological importance.

The parent company of West Witwatersrand Areas—the consolidated Gold Fields of South Africa, Ltd.—expects that its programme of drilling and exploration in the area of about 86,400 claims to the south of the mineral holdings of the former company (immediately below the line of mines from Libanon to Doornfontein) will take about two years to complete.

Montrose Exploration, which has experienced difficulties in marketing chromite from its Lydenburg deposits normal to a weak mineral market, has now entered into a long-term contract with the Allied Chemical Corporation of New York for the supply of the ore. In addition that Corporation has arranged to acquire 51% of the share capital of Montrose, which holding will include 235,142 shares at present in reserve and shares to be acquired in an undisclosed proportion from other parties, probably General Mining and Finance Corporation, Alpha Free State Holdings, and others. Allied Chemical's holding will be held by its wholly-owned South African subsidiary. In addition to its chromite deposits the Montrose company owns mineral rights over about 131,000 acres in various parts of the Transvaal. General Mining and Alpha Free State will retain shareholdings and representation on the board.

Blyvooruitzicht Gold Mining, which is advancing

Sinking Record at President Steyn.

From Left to Right: S. Spiro (Chairman, President Steyn); H. MacConachie and R. Blair (Consulting Engineers); A. K. Richards (Master-Sinker); J. J. Cronse (Welkom Township).

exploratory development in the western section where values are expected to be of a lower-grade than eastwards, expects the effect of such ore on the overall yield to be influenced by processes of beneficiation—for example, surface waste-sorting. This should raise the effective capacity of the mill although the company has no present plans for expanding milling capacity.

Hartebeestfontein Gold Mining has had improved reef development values from the deeper zone since June-end. In the period to November 30, 82·3% payable averaged 364 in.-dwt. against 76·2% averaging 291 in.-dwt. in the previous 12 months and the ore reserve average of 378 in.-dwt. at the end of June. The indicated bore-hole grade range was from 200 in.-dwt. to 360 in.-dwt. with payability of 70% and upwards. Preliminary operations for the sinking of No. 4 Shaft, in the extreme south-western section are proceeding.

The exploratory development at depth being advanced by Carrig Diamonds, Ltd., from pilot winzes has so far located two fissures of an impressive strike length, both within the present lease area and beyond it, in ground over which a (further) lease has been applied for. To accelerate development and the initiation of "shrinking" stoping deepening the shaft system is proceeding. The new disclosures have materially improved the ore-reserve position, expected to improve further. The availability of external power supplies has reduced costs. Waste sorting in the new plant has been raised to 33%, has beneficiated the grade, and very substantially increased the effective capacity of the treatment plant, in which another grease-table has been installed. Output is being considerably supplemented by treating accumulated tailings at the rate of 28·9 carats per 100 loads of tailings treated. Benefits from the deep-level disclosures will become fully evident in production in about 12 months.

The African-Asbestos-Cement Corporation, Ltd., has initiated a new development programme at its Kalkloof chrysotile property, which is expected to add a substantial tonnage to reserves from new zones. A grading plant is being erected at the property and should be commissioned soon.

The results of the recently-completed survey of its asbestos holdings conducted by Stoltzburg Asbestos (Chrysotile) Holdings disclosed very large reserves of short-grade fibres; an indicated extraction rate of up to ½% for low No. 4 grade; 1·75% for Nos. 4 and 5; upwards of 2% for No. 6, but that until No. 6 prices improve to reasonable levels operations will remain unprofitable. The mine, therefore, remains on a caretaking basis.

Iron and Steel.—Reflecting the progress of the expansion programme still proceeding iron ore output of the S.A. Iron and Steel Industrial Corporation was increased in 1958–59 to 2,517,000 tons from its Thabazimbi (Transvaal) and Sishen (Cape) deposits for its own steelworks, which raised ingot steel production by 93,000 tons to the record figure of 1,740,000 tons. Exports included 102,256 tons of pig-iron and 57,387 tons of steel. Steel product sales amounted to 1,228,200 tons.

While towards the end of 1958 the domestic demand for steel products markedly declined, with consequent intensification of competition especially in the export markets, more recently the position improved and prices tended to harden. Export demand has continued into the 1959–60 year, especially from Japan, the United States, Argentine, Soviet, Pakistan, and the United Kingdom. The 1958–59 development saw commissioned the new shaft at the Dannhauser colliery, the new Glen Douglas dolomite quarry, the dense-medium ore benificiation plant at Thabazimbi, and two new coke-oven batteries, etc. Considerable funds have been devoted to the treatment and re-use of industrial waters and effluents.

Central African Federation.—The Rhokana Corporation, which has completed sinking of the No. 2 Mindola vertical shaft to a depth of 2,880 ft, is now installing the permanent steelwork in the shaft

and constructing the reinforced-concrete headframe in which the Koepe winder will be installed. About 800 ft. from the No. 2 shaft sinking the sub-vertical shaft from 2,630 ft. to 3,940 ft. was in its early stages. Like No. 1 Shaft the two other shafts mentioned will facilitate and serve operations in the deep-level zone of the ore-body. The No. 2 shaft, which will be commissioned for ore hoisting early in 1960, will impart greater flexibility to mining operations, particularly in so far as the proportions of ore from the three sections—Nkana, Mindola, and Nkana South—can henceforth be varied according to metallurgical requirements for both copper and cobalt. Also scheduled for commissioning early in 1960 is a plant incorporating fluid-bed roasting and electro-deposition of both copper and cobalt. Modifications to the sulphuric acid plant have raised the effective capacity above the rated level, while the sulphur dioxide content of the gas feed from the converter section of the smelter has been raised by modifications there. In the concentrator all primary mills have been converted to rod charge; six mills have been extended to 12 ft. length, and a bank of Fagergren cells installed and commissioned.

Bancroft Mines, despite extensive sealing of fissures in the main rock-passes, continues to experience muddy conditions in broken ground and consequent difficult loading and handling conditions in the shaft. In order to improve matters washing plant equipment previously on surface has been installed underground. This will facilitate separation of the fines from the coarse fraction before hoisting and pumping the fines as a pulp direct to the concentrator. Because of the possibility of encountering heavily-watered ground in deepening the vertical shaft it has been decided instead to open up the deeper levels by inclined twin-shaft systems in relatively water-free beds. Unwatering ahead of operations is to be effected by a 14° incline haulage from 1,150 ft. to 1,400 ft., which level will be opened up for unwatering immediately and concurrently with advancing the sinking of the main inclines. The latter will be advanced to a vertical depth of 2,600 ft. below surface. Pumping at the rate of about 20,000,000 gallons a day has steadily lowered the water-table, but with operations deepening further unwatering will be required. Heavy folding and variations in dip disclosed as development progressed has necessitated an increased rate of sub-level development beyond the planned footage. Compensating for this additional effort these geological anomalies have been accompanied by an occurrence of an ore-body in ground previously thought to be barren, with benefits to the ore reserve.

Trade Notes

Brief descriptions of developments of interest to the mining engineer.

Reconditioning the Frame of a Symons Cone-Crusher

Symons cone-crushers are manufactured in Great Britain at the Erith works of the **General Electric Co., Ltd.,** under license from the **Nordberg Manufacturing Co.** These machines are well known for their hard wearing qualities and running replacements are normally confined to the head, bowl, and frame liners. The bearing surfaces and some of the moving parts have to be renewed at comparatively long intervals, but a major overhaul is only necessary after many years of continuous service. In special circumstances, however, after long periods of overloading, the face at the top of the main frame, on which the spring-loaded adjusting ring rests, may at times be subject to undue wear and a special method has been developed for reconditioning it if necessary, which obviates the costly replacement of the whole frame.

The function of the adjusting ring is to hold the crushing bowl in position with respect to the crushing head. Eight pins projecting from the top of the main frame keep the ring correctly aligned and it is held down by a circle of heavy springs, the purpose of which is to allow the bowl to rise and let through tramp iron or other uncrushable material that would otherwise jam in the bowl and might damage the driving mechanism. Should the feed to the crusher contain lumps of ore appreciably larger than the size that the crusher is set to take, or should the ore be exceptionally hard and tough, the bowl tends to rise to relieve the stresses. If the proportion of such lumps should be excessive the continual jarring of the adjusting ring is likely to cause undue wear on the pins at the top of the main frame and on the bolts and bolt holes securing the springs. The top of a frame in such a condition can be seen on the right of Fig. 1 and wear to this extent entails a major reconditioning operation.

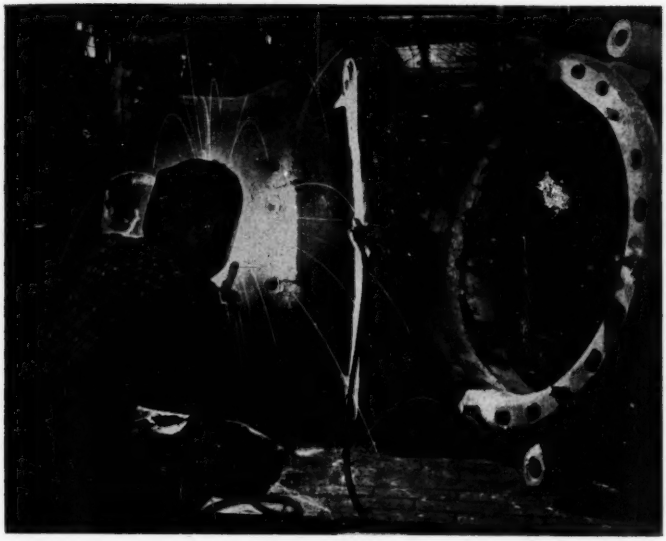


Fig. 1.

The main frame is a large steel casting which calls for a considerable amount of accurate boring and facing in order that the crushing and driving members may be correctly located in position inside. As it is a costly item to replace, and is subject to little wear except at the top, a technique has been developed for cutting off a worn top and welding on a new section, thus making it unnecessary to scrap the whole frame. It must be emphasized that this reconditioning operation is not common practice ; it is only required if the crusher has been abused or if it has had to handle abnormally hard or tough rock.

In carrying out the repair the top of the frame is cut off in a vertical lathe just below the lugs which support the feed platform and a new top of the correct depth is cast to replace the worn section. The lower section of the frame is mounted in a vertical borer and machined to leave a circular spigot on its upper surface to fit a corresponding groove which has been cut in the underside of the new top section. While the frame is still in the borer the inner and outer edges of its top face are cut to a 30° taper. The bottom edges of the new top section are also machined to a similar taper and thus a 60° V groove is formed for welding on both sides of the frame when the two sections are put together, the circular spigot locating them accurately in position. The joint is electrically welded on both sides as shown in Fig. 1. On the right of the operator can also be seen the worn upper section which is being replaced by the new top. After welding the joint is ground smooth and the crusher is re-assembled. Fig. 2 shows the complete machine after the reconditioning operation of Fig. 1, no trace of the weld being visible.

Reconditioning as described above has been

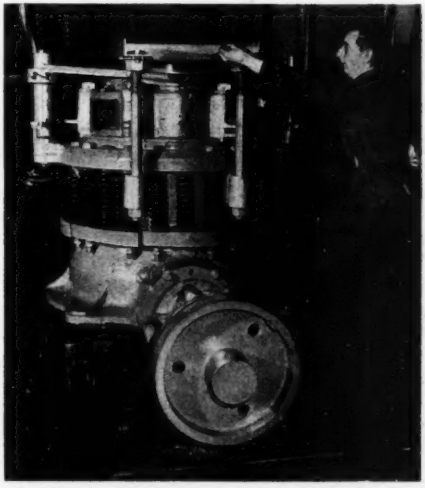


Fig. 2.

carried out with Symons cone-crushers up to 4 ft. in size and has always proved satisfactory. The machining required is straightforward and the whole operation is considerably cheaper, even for a crusher as small as 2 ft., than the cost of casting and machining a new frame.

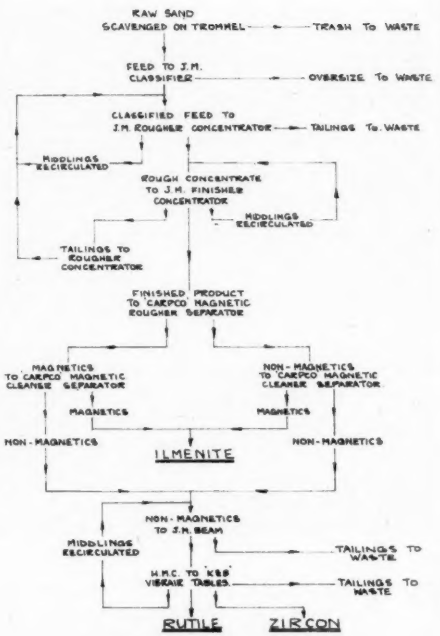
Dry Concentration

At a demonstration recently staged by **Knapp and Bates, Ltd.,** of 14–17, Finsbury Court, London, E.C. 2, in conjunction with **J. R. F. Joyce, Ltd.,** of Stokenchurch, Bucks., representatives of the technical Press, were shown the novel Joyce-Martienssen concentrator in action. The demonstration had been prepared to show how large tonnages of relatively poor sands can be treated when only sun dried and how the bulk concentrate produced can then be efficiently separated into its different constituents without any other heat treatment, an approach obviously applicable to arid and semi-arid regions.

In a typical flow-sheet, even as that illustrated, the first stages of concentration are carried out in the Joyce-Martienssen device, the essential principle of which is that dry granular material flowing at an even velocity down an inclined trough tends to form layers in which the heavier particles collect nearest the surface of the trough while the lighter particles ride above. At intervals the trough is pierced by a pattern of holes of such shape and aperture that heavier particles tend to pass through, while the lighter and upper section of the bed are supported and pass on. In the example shown a six-fold beam treated the feed 36 times in one pass acting as a classifier-rougher. On second pass it is used as a finisher. Tailings from the first stage are discarded, while those from the finisher stage are returned to the first stage. It is claimed that concentration ratios of the order of as high as 50 : 1 can be attained in this way.

The elevation of middlings is done by a Joyce-Scott vacuum elevator, which has the advantage that no working parts except the face of the discharge valve are exposed to the abrasive action of the particles and it is, like the concentrator, light, robust, and readily portable. The elevators used on the beam had a rated capacity of 1,500 lb./hr. to a height of 22 ft. with the expenditure of only $\frac{1}{3}$ h.p.

In the flow-sheet demonstrated the product



Treatment of Mineral Sands.

from the finisher concentration was next treated to remove a strongly-magnetic concentrate of ilmenite, this stage in the demonstration being done on a Carpco induced-roll laboratory magnetic separator. The magnetic fraction was finished ilmenite of a purity acceptable to manufacturers. Normally, the non-magnetic fraction would then be treated on a second Joyce-Martienssen beam to reduce the barren quartz content, thus producing a concentrate containing the remaining heavy minerals. This second concentrate would be subjected to a further stage of magnetic separation which would remove as a concentrate the remaining less strongly magnetic ilmenite and magnetic rutile.

A further pass on a beam then upgrades the final concentrate for treatment on the K & B Vibrair table on which zircon is separated from rutile. This separation between two materials of almost equal density takes place by virtue of the shape difference in the particles. On production-scale work the middling produced at this stage might be subjected to further treatment on another table with different adjustments to the air flow and slope.

Personal

R. J. BURDON has left for Australia.

J. A. COWPERTHWAITE is home from Southern Rhodesia.

C. P. DENNISON has left for Northern Rhodesia.

J. E. DENYER has been appointed chairman of South Crofty, Ltd., and a director and chairman of Great Western Ores, Ltd., on the resignation of Mr. THOMAS PRYOR.

M. F. ENDEAN is now in South Africa.

L. G. FINCH has been appointed local director and controller of the research department of Hadfields, Ltd., on the resignation of Mr. T. H. ARNOLD.

M. L. FITZGERALD is now in Australia.

G. S. HARRIES is home from Malaya.

T. T. HEYWOOD has left to take up an appointment in Caracao.

A. J. W. LEGGE is now in Rome.

T. MARRACK has left for Peru.

J. E. PHILPOTT has left for Ghana.

W. L. STAPLETON is now in Australia.

H. L. SWIFT has left for Nigeria.

R. J. E. THOMAS is home from Gambia.

D. V. G. TREGASKIS is leaving shortly for Malaya.

E. J. WAYLAND is here from Uganda.

W. H. WILSON has left for India to take up the Professorship of Metalliferous Mining at the School of Mines, Dhanbad, under the Colombo Plan.

A. C. P. WYNNE is now in Eire.

WALTER MAXWELL HENDERSON-SCOTT, who died on December 6, was at the Royal School of Mines, where he was de la Beche medallist in 1907. Awarded an Institution of Mining and Metallurgy postgraduate scholarship he went out to Colorado, thereafter working in the United States until 1910 when he went to Canada. In 1912, however, Major Henderson-Scott left for Brazil on a prospecting expedition and until the outbreak of hostilities in 1914 he practised in South Africa. During the 1914–1918 war he served continuously in France, on demobilization in 1919 becoming Secretary of the Imperial Mineral Resources Bureau. From 1925 to 1928 Major Henderson-Scott was principal of the Mineral Resources Department of the Imperial Institute. In 1930, however, he resumed consulting work and practised until 1938, when his interest turned to mining finance. A director of several companies and a Member of the Institution of Mining and Metallurgy Major Henderson-Scott had been retired for a number of years.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Associate Member to Member.—Dacre Christopher BARRETT, A.C.S.M. (*Jos*); Gurbachan Singh MARAWHA (*Dhanbad, India*).

Associate Member.—Roger Ernest BARNES, A.R.S.M., B.Sc. (*Obuasi*); David Smedley COX, A.R.S.M., B.Sc. (*Penang*); Keith Ronald GREENLEAVES, B.Sc. (*London*); Anthony Eden GREVILLE, M.Sc. (*Johannesburg*); Derek HEYWOOD-WADDINGTON, A.C.S.M. (*London*); Peter Hardy JENNINGS, Ph.D. (*Montreal*); George Campbell Roy McDONALD, A.C.S.M. (*Perak*); Douglas Newlands MOIR, A.R.S.M., B.Sc. (*Stevenage*); John Kenneth SHANKLIN, B.Sc. (*Wrexham*).

Student or Affiliate to Associate Member.—Ian Robert Malcolm CHASTON, A.R.S.M., B.Sc. (*Ipoh*); Patrick Denis COAKLEY, A.C.S.M. (*Jos*); Seng Hon CHAN, A.C.S.M. (*Kuala Lumpur*); Clifford Henry JAMES, Ph.D., D.I.C. (*Salisbury, S. Rhodesia*); Paul JARVIS, A.R.S.M., B.Sc. (*Kilembe*); Brian Robert Emmett KERNS, A.C.S.M. (*Flin Flon*); Leong Sing LIM, A.C.S.M. (*Perak*); James Samuel RUSSELL-REDMAN, B.Sc. (*Romford*); Brian Rutherford SHEPPARD, A.R.S.M., B.Sc. (*Stilfontein, Transvaal*); John WHITEHEAD, A.C.S.M. (*Cardiff*).

Affiliate.—John Yahaya DANKARO, A.C.S.M. (*Camborne*).

Student.—David ABRAHAM, B.Sc. (*Leeds*); Joseph ANSAFO-MENSAH (*Camborne*); Robert Mackie BAIRD (*London*); Thomas Graham BANKS, B.Sc. (*London*); Derek John BARRATT (*London*); Antony Charles Thomas BIGG (*Hatfield*); Desmond Howell BOLTON (*Leeds*); Anthony Albert George BOWERMAN (*Bude*); Christopher Michael Lance BOWLER, Ph.D., B.Sc. (*Kalulushi, N. Rhodesia*); John Louis COLLIER (*Victoria, Australia*); Brian Ronald Martin COLLINS (*Woking*); Hugh Christopher COUNSELL (*Farnham*); John Anthony COX (*London*); Ronald CREASY (*Dawlish*); Brian Colin DAVENPORT (*London*); Reginald John D'ELBOUX (*Camborne*); Jeremy Brian EVANS (*Lingfield*); Andrew John FRANKLIN (*Teddington*); Peter John GOODWIN (*Sheffield*); Ivan Cecil Adeyemi GORDON (*Camborne*); Peter GREATWOOD (*Cambridge*); Jill Raymonde HARVEY, B.Sc. (*London*); Robert Arthur HUGHSON, A.H.W.C. (*Edinburgh*); James JOHNSTONE (*Glasgow*); Michael Lown JONES (*London*); Noel Anthony KEARNS (*Mitcham*); Tan Wee KIAT (*London*); Peter LAMMYMAN (*Sheffield*); John LOVERING (*London*); Ian Alexander Brown LOW (*Manchester*); Saw LWIN, B.Sc. (*Camborne*); Roderick MACLEOD (*Redruth*); Donald Charles Douglas PARKER (*London*); Paul Dennison POTTER (*London*); Michael John PROUDFOOT (*Redruth*); John Golin ROGERS (*Perak*); Brian SMITH (*Sheffield*); Nigel STONESTREET (*Christchurch*); John Bryan THOMAS (*St. Austell*); Charles Spencer THURLOW (*St. Austell*); M. B. TWUM-ANTWI, A.C.S.M. (*Camborne*); Socrates Theodore VARTSOS, B.Sc. (*Fort Victoria, S. Rhodesia*); Byron Ettore VERAS (*London*); Gerard Edward WOOD (*Leeds*); Harry Beresford WORTLEY (*Selukwe, S. Rhodesia*).

Metal Markets

During December [1]

Copper.—Although the Christmas holiday makes December a short working month there has been no lack of activity in copper. Unfortunately much of the excitement connected with movements in Metal Exchange prices [2] has been somewhat abortive, as the market has remained sensitive—some feel unduly sensitive—to the state of labour negotiations at the United States mines and smelters.

[1] Recent prices, pp. 8, 48.
[2] See Table, p. 48.

Especially irritating was progress towards a new wage contract between Kennecott Copper and the Mine Mill union. One week it was felt to be "all over bar the shouting" and copper turned quite a bit easier. Subsequently, however, the local unions took an unexpectedly long time to ratify the agreement reached at a national level and it was not until some time later that the way was clear for a resumption of work. Even now there is no production of copper, as details still remain to be settled with certain small unions.

American Smelting and Refining Co. is another big producer which settled with the major union—Mine Mill—in the past month, but the American industry could still fairly be described as strike-bound. However, while prices there and in Europe for spot metal remain at a high level it is noticeable that forward prices are much more modest. In London the three months price settles down very readily at £240 per ton and in America the custom smelters are quoting 35 cents per lb. for February delivery, the first available, even though they could obtain nearer 40 cents for spot metal. In this connexion it must be remembered that in Europe, especially on the Continent, specifiable electro wire-bars for prompt delivery command a premium over the cash price of up to £20 per ton (and therefore of, at times, £40 per ton over three months).

The year 1959 could certainly be classified as the year of the big strike. Not only has the dispute in the U.S. copper industry been big in itself, although less big than the steel strike, but its effects have overshadowed the market in all 12 months of the year and are not finished yet. Nevertheless it is a telling comment on the degree of forewarning which consumers in all parts of the world had that it is only now, after the loss of something like a quarter of a million tons of metal, that there is beginning to be any sign of shortage.

Consumption of copper in the U.K. in October was 61,101 tons, of which 47,345 tons was refined. Production of primary refined was 7,992 tons and of secondary refined 9,194 tons. Stocks of refined copper were down to 54,002 tons, as were those of blister to 10,600 tons.

Tin.—The feature of the December tin market [1] has, of course, been the new 1960 first-quarter export quota, announced following the Tin Council meeting in London. To the surprise of not a few people this was advanced to 36,000 tons, or very nearly 100% of the rate of exports in the base period prior to the introduction of restrictions. Time alone, of course, will tell whether this was unduly generous, but sundry prophets have claimed that the market emphasis is likely to be weak rather than strong as a result. Certainly it appears that the Buffer Stock Manager's activity on the Metal Exchange for much of December has been on the buying rather than the selling side. One factor which has tended to add colour to the view that the market is due for a weaker spell in the not too distant future is that, contrary to general opinion, it has been made known officially that the Buffer Stock is likely still to hold 10,000 tons at the end of 1959, not to mention the 2,500 tons which it is to dispose of for the U.K. Government. In view of the possible need to run this stock down before the end of the current agreement (in mid-1961) the figure is rather larger than some people consider to be safe.

[1] See Table, p. 48.

Much will still hang on the way in which demand from the American tinplate industry develops later in 1960, when, it is hoped, the steel strike question will have been finally solved. From the tempo of most other metal markets it would be reasonable to infer that this might be on a fairly good scale.

Tin consumption in the U.K. in October, 1959, was 1,915 tons and production 3,101 tons, an increase. Stocks were steady at 10,624 tons.

Lead.—Despite the appearance from time to time of a more or less technical tightness in nearby metal on the Metal Exchange [1] lead remains basically in an unsatisfactory statistical position. This is most tellingly reflected in the decision of certain producing companies to retain restrictions on supplies to the market, despite the restoring of deliberate cuts in the volume of supplies made earlier in the year in the case of zinc. What lead most needs, apart from a radical new use, is a revival in the cable industry coupled with a halt to the process of losing ground to plastics.

U.K. October consumption was 32,926 tons, so that 1959 is still just ahead of 1958. Production was 8,765 tons and stocks dropped to 56,697 tons.

Zinc.—Apart from the supply restriction decision already noted the main feature of interest in zinc was the release by the U.K. Government of a further 3,000 tons from its stocks in December. Now that it is felt that at any rate a little later in 1960 supplies on the market will be a little freer some people are declaring that present prices are too high.[1] Certainly they reflect a degree of success in adjusting the market from a depressed position that few people foresaw earlier this year. Due credit must, however, go to the consumption side, which has maintained a healthy tone throughout.

Zinc consumption in the U.K. in October was 30,686 tons and production 5,106 tons. Stocks dropped to 35,994 tons.

Iron and Steel.—At the beginning of December it was disclosed that the November output of raw steel was a new all-time record, production reaching an average of 458,600 tons a week as compared with the previous best of 443,200 tons a week set up in May, 1957. Although December production was a little lower because of holidays it was still very high and the month was made more lively by the announcement of important development programmes.

Thus the steel industry rounded off 1959 with a high level of production and with the prospect of bright conditions in the New Year. This is vastly different to the poor situation which existed at the beginning of 1959. Indeed, the general recovery in demand is at such a pitch now that the word "shortage" is again creeping back into the steel buyer's vocabulary. Steelmakers hold a good volume of orders and delivery dates are tending to lengthen, although the revival in the demand for steel continues to favour the producers of light steel products. The pressure for sheets, in particular, remains unabated and consumers here are still having to rely upon overseas material to supplement supplies from home mills. Requirements of small bars and sections, strip, wire, reinforcing rounds, tinplate, and stainless and alloy steels are also at an impressive level.

Although there has been some improvement at the heavy end of the trade requirements from

[1] See Table, p. 48.

certain consumers are still limited. Uncertain conditions in the shipyards, the coal mines, and the railways are restricting the flow of orders from these markets. However, constructional engineers are taking bigger tonnages of structurals while other users of plates, particularly the lighter gauges, have recently been showing a livelier interest.

The month was dominated by the new development schemes announced by some of the major steel producers in Britain. These included the Steel Company of Wales's plan (still to receive official approval) to raise their production to 3,650,000 tons a year from the current 3,000,000 tons and to increase the output of sheets and tinplate. The most important part of this plan is the provision of a 48-in. hot strip mill, which will be built alongside the existing 80-in. mill. A continuous casting plant for slabs (the first really large-scale plant of its type in the U.K.) is also planned.

Another leading sheet and tinplate producer—Richard Thomas and Baldwins—is also engaged on the expansion of production. The company, which has just started building a new integrated works near Newport, South Wales, has received an additional £10,000,000 from the Government in order to accelerate the completion of the plant. The company placed orders for two blast-furnaces and a hot strip mill during the month. Full production is expected to be achieved in 1962.

Another most significant development was presaged when Steel, Peech, and Tozer (Rotherham), a branch of the United Steel Companies, disclosed that it is to spend £10,000,000 on the replacement of all its existing 21 open-hearth furnaces by six electric-arc furnaces of 110 tons capacity each. When completed (in about five years time) the Rotherham works will be the world's largest electric steel-making plant.

Aluminium.—The big event of the month as regards aluminium was, of course, the rise in the price of Canadian and American virgin metal to some £186 a ton. Ever since cheap offerings of Russian material became virtually non-existent some weeks ago some quarters have regarded a price increase by Canadian and U.S. producers as being certain, although others, while agreeing that £180 a ton was a low level at which to sell, have been a little more cautious in view of the surplus production capacity available.

Nevertheless the strength of the market in recent weeks and the increasing demand for metal from all quarters of Europe can be regarded as having given Aluminium, Ltd., the final green light whereby it initiated the rise a day earlier than its U.S. rivals. By doing so at a time when wage negotiations in the American industry were nearing conclusion the Canadian producer appeared to be trying to establish a reasonable new level, as it was known that the U.S. companies were anxious to advance by as much as 2 cents a lb.

The strength of the aluminium scrap market, referred to last month, continues to grow. Although rising prices had already discounted the rise in virgin prices to some extent, dealers were still able to advance their prices for most grades of scrap in the week before Christmas, mainly as a result of a continued heavy demand. Secondary alloy ingot makers were also forced to advance their prices in December to compensate for the continued rise in scrap values.

Antimony.—The market in antimony was quiet again in December, with quotations very much in line with those of the past few weeks. English regulus is again fetching £197 10s. a ton delivered for 99·6% material, while 99% metal is priced at £190. Details of United Kingdom antimony consumption in October were announced just before Christmas. According to the figures consumption of new metal in the first 10 months of the year was somewhat down on that during the corresponding period of 1958—3,887 tons, against 3,947 tons. Consumption of antimony in scrap in the same period, however, was up by a rather bigger margin—3,775 tons, against 3,688 tons.

Arsenic.—Arsenic prices remained stable throughout December, as they have done for some time past. The metal is still quoted at £400 a ton, while arsenic trioxide is again fetching £40 to £45 a ton, ex stock.

Bismuth.—Trading in bismuth has again been quiet and its price is unchanged from that of recent months—namely, a nominal 16s. a lb. for one-ton lots ex warehouse.

Cobalt.—The open-market price for cobalt throughout December remained at 14s. a lb., delivered, as in November. The United Kingdom contract price for delivered metal is again 12s. 6d. a lb., while the black and grey oxides continue to be quoted at 9s. 1d. and 9s. 8d. a lb. respectively, delivered in this country.

Cadmium.—After the mid-November rise in the prices of U.K. and Empire refined metal in this country sellers have again advanced their prices by a further 6d. U.K. and Empire metal is thus now quoted at 10s. a lb. for 1-cwt. lots. At the same time asking prices for metal from foreign sources have also been raised 6d., the range now being from 10s. to 11s. The quotation here is thus once again at its usual relationship to Continental prices. There has been talk during the month of yet another rise in United States prices, but as yet no such move has materialized.

Chromium.—Trading in chromium metal continued its steady course during the month with no price move nents. Sellers are now asking from 6s. 11d. to 7s. 4d. a lb.

Tantalum.—The price of 60% tantalum ore was steady throughout December at 650s. to 700s. c.i.f.—a level at which it has held all through the last quarter.

Platinum.—The platinum market was quieter in December than for some little time past, but prices have remained at the levels established half-way through November without displaying anything more than the very slightest softer undertone. Thus U.K. and Empire metal is again available at £28 10s. a troy oz., while imported metal is still fetching £27 5s. to £27 15s.

Iridium.—Only very little business, if any, has been done in iridium of late and iridium sponge and powder is again priced nominally at £24 to £26 15s. a troy oz.

Palladium.—Like platinum palladium has been going through a very quiet spell in the last month, after a period of marked activity in November. Some quarters feared that November's price gains would soon be lost again, but up to the present there is no sign of any marked trend to a move in either direction. The present price of palladium in the United Kingdom is £8 12s. 6d. a troy oz.

Osmium.—Trading in osmium continues to be very quiet and last month's nominal quotation of £23 to £32 5s. an oz. is again unchanged.

Tellurium.—Tellurium is another metal of which

prices have remained steady throughout December as for some months past. Lump and powder 99% to 95% is still quoted at 18s. a lb. Tellurium sticks continue to fetch 20s. a lb.

Tungsten.—British Tungsten, the Government agents, re-entered the tungsten ore market in December with a quota of 80 tons of ore for disposal. About half of it remained on the market almost all through the month, although merchants disposed of some useful tonnages from the outset. Prices remained in the range 147s. 6d. to 152s. 6d. a unit—the level attained at the end of November—until the week before Christmas, with U.K. Government material selling at the top price for forward material and 2s. 6d. over for prompt. Later the market took on a slightly sluggish trend and prices softened a little to 147s. to 152s. a long ton unit. Immediately after the holiday, however, there was a strong burst of consumer buying, which cleared the remaining Government material and something like 300 tons or merchants' ore as well. In consequence the end-month prices were marked up to 148s. 6d. to 153s. 6d.

Nickel.—Once again there is little or nothing to be recorded about nickel from the market point of view, except that its price is still £600 a ton.

Chrome Ore.—A good demand from European consumers for ferro-chrome during December augurs slightly better than of late for Scandinavian producers, who are no longer faced with a serious shortage of hydro-electric power. In its turn this promises slightly better chances for chrome ore producers in the coming months. As yet, however, there has been very little change in the market position of this ore.

Rhodesian metallurgical ore and Turkish material are still quoted at £15 15s. a ton c.i.f. and a nominal $33·5 a ton, respectively.

Molybdenite.—Of late there have been rumours that molybdenum ore supplies are growing tighter, particularly in view of the fact that demand for ferro-molybdenum from Scandinavian sources has risen sharply in the past few weeks. In actual fact, however, such rumours appear to be largely unfounded at present and prices have certainly remained very constant throughout last month, while the rate of arrivals recently has risen.

Climax are currently asking 8s. 11d. a lb. of Mo contained, f.o.b. mine, while other sources are asking 9s. 3½d. a lb., c.i.f.

Manganese Ore.—The manganese ore market remained generally much the same throughout December as it did throughout the previous month. India, having at last agreed the terms of the barter deal with the U.S. Commodity Credit Corporation, which she has been negotiating for the last three years or so, advanced her prices by about half a dollar a ton.

As far as the open market was concerned South Africa probably enjoyed the biggest volume of sales during the month, but it now seems that a lot of the material disposed of came from existing stocks and she is now having to book orders for ore that has yet to be mined. The overall statistical position is far from encouraging at the moment and prices show no tendency to advance from the nominal 68d. to 73d. a unit now being asked for 46% to 48% material, c.i.f. U.K.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum, 99·75% ; Copper, electro ; Lead, minimum, 99·75% ; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Dec. 11	791 10	787 10	259 5	241 17½	72 2½	72 1½	97 2½	91 1½
14	789 0	783 10	255 15	237 15	71 16½	71 13¾	95 2½	89 13¾
15	788 0	781 15	252 5	236 5	71 16¼	71 11¼	96 2½	90 12½
16	789 0	783 10	255 5	239 15	72 3¾	72 3¾	95 2½	90 7½
17	788 0	783 10	251 5	236 5	72 8¾	72 3¾	94 15	90 3¾
18	789 0	784 5	251 15	236 15	73 1¼	72 8¾	93 7½	89 12½
21	788 10	783 5	260 10	241 15	73 1¼	72 8¾	93 17½	89 17½
22	788 10	783 15	258 5	240 15	73 16½	73 5	94 7½	90 7½
23	790 0	784 5	259 5	241 5	74 7½	73 10	95 2½	90 7½
24	787 10	783 5	260 5	241 10	74 2½	73 7½	95 7½	90 6¼
25	—	—	—	—	—	—	—	—
28	784 10	782 5	262 5	243 5	74 12½	73 13¾	95 17½	90 6½
29	786 0	782 5	262 5	244 15	75 6¼	74 10	96 2½	90 8¾
30	786 0	782 15	258 5	241 5	73 18¾	73 7½	95 8¾	90 2½
31	785 10	782 5	255 5	239 17½	73 17½	73 3¾	94 16¼	89 17½
Jan. 1	—	—	—	—	—	—	—	—
4	786 0	782 5	253 5	239 5	74 12½	73 13¾	94 12½	89 12½
5	791 0	7.5 15	254 15	241 15	75 2½	74 2½	95 7½	90 10
6	789 0	784 15	254 5	242 7½	74 15	73 15	95 11¼	90 11¼
7	794 0	785 5	253 15	243 12½	74 12½	73 18¾	95 12½	90 12½
8	790 0	787 10	250 10	242 12½	74 17½	74 3¾	95 7½	90 8¾
11	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	Nov.		Dec.	
	Treated Tons	Yield Oz.†	Treated Tons	Yield Oz.*
Blyvooruitzicht	125,000	83,220	123,000	80,867
Brakpan	139,000	17,227	143,000	17,202
Buffelsfontein‡	145,000	55,963	145,000	56,350
City Deep	105,000	22,050	97,000	20,418
Cons. Main Reef	90,000	16,366	75,000	15,480
Crown Mines	204,000	33,895	207,000	34,113
Daggafontein	230,000	46,580	219,000	44,467
Doornfontein‡	95,000	38,641	93,000	38,032
D'rb'n Roodeport Deep	194,000	35,415	186,000	34,361
East Champ D'Or‡	12,000	298	12,000	303
East Daggafontein	103,500	17,543	100,000	16,959
East Geduld	133,000	39,235	132,000	39,257
East Rand P.M.	211,000	55,225	203,000	54,291
Eastern Transvaal Consol	18,900	6,250	18,800	6,193
Ellaton‡	30,000	6,964	29,000	6,792
Freddies Consol.	60,000	14,350	54,000	13,015
Free State Geduld	94,000	80,501	93,500	80,647
Geduld	72,000	13,500	72,000	13,513
Government G.M. Areas‡	50,000	10,521	51,000	10,617
Grootvlei Proprietary	215,000	44,939	210,000	43,890
Harmony Gold Mining	136,000	54,403	141,000	56,478
Hartebeestfontein‡	104,000	50,960	101,000	48,480
Libanon	114,000	26,964	110,000	25,750
Loraine	80,000	16,200	77,500	15,888
Luipaards Vlei‡	122,000	13,963	118,000	13,496
Marievale Consolidated	94,000	22,748	94,000	22,741
Merriespruit‡	—	—	—	—
Modderfontein East	128,000	12,862	122,000	12,782
New Kleinfontein	82,000	10,495	80,000	9,878
New Klerksdorp‡	10,400	1,322	10,200	1,234
President Brand	115,000	94,918	115,000	94,642
President Steyn	104,000	41,189	99,000	39,193
Rand Leases	190,000	28,310	163,000	24,857
Randfontein‡	196,000	13,758	189,000	13,461
Rietfontein Consolid't'd.	16,000	4,293	16,000	4,247
Robinson Deep	54,500	10,100	50,000	9,000
Rose Deep	25,000	4,347	25,000	4,504
St. Helena Gold Mines	150,000	48,376	150,000	49,120
Simmer and Jack	76,000	14,879	73,000	13,794
S. African Land and Ex.	94,500	19,704	90,000	18,764
S. Roodepoort M.R.	29,000	6,912	30,000	7,235
Spaarwater Gold	11,000	3,426	10,600	3,339
Springs	105,000	14,458	101,000	13,891
Stilfontein Gold Mining‡	160,000	71,985	160,000	72,037
Sub Nigel	66,500	15,431	64,000	15,088
Transvaal G.M. Estates	6,700	1,841	—	—
Vaal Reefs‡	97,000	43,651	93,000	41,850
Van Dyk Consolidated	70,000	12,879	69,000	12,537
Venterspost Gold	123,000	31,531	121,000	31,194
Village Main Reef	32,000	4,464	29,500	4,310
Virginia O.F.S.‡	136,000	30,910	132,000	29,832
Vlakfontein	123,000	31,531	49,500	17,913
Vogelstruisbult‡	90,000	19,238	87,000	18,732
Welkom Gold Mining	98,000	30,961	95,000	30,220
West Driefontein‡	110,000	100,667	110,000	100,657
West Rand Consol.‡	208,000	20,455	200,000	19,392
Western Holdings	138,000	89,798	140,000	93,128
Western Reefs	138,000	37,260	134,000	36,516
Winkelhaak	69,000	19,493	79,000	22,917
Witwatersrand Nigel	18,800	4,385	18,300	4,272

† 249s. 7d. * 249s. 11d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept.,* 1958	16,760,400	65 10	46 9	19 1	25,633,898
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	16,540,150	67 7	47 10	19 9	25,934,441
Jan., 1959	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	16,743,500	68 0	45 4	22 8	25,934,881
April	—	—	—	—	—
May	—	—	—	—	—
June	17,845,100	69 1	45 2	23 11	28,473,191
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,214,200	70 5	45 2	25 3	30,140,529

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
December 1958	1,480,525	40,372	1,520,895
January, 1959	1,506,670	39,515	1,546,187
February	1,472,090	34,618	1,506,708
March	1,561,196	32,271	1,593,467
April	1,616,891	36,815	1,653,706
May	1,641,990	30,371	1,672,361
June	1,665,503	34,465	1,699,968
July	1,700,968	48,414	1,749,382
August	1,699,098	36,052	1,735,150
September	1,701,485	36,567	1,738,052
October	1,718,916	33,576	1,752,492
November	1,688,379	34,903	1,723,282

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
March 31, 1959	379,257	32,982	412,239
April 30	383,710	33,081	416,791
May 31	385,278	33,186	418,464
June 30	383,903	33,146	417,049
July 31	381,190	33,295	414,485
August 31	377,257	32,994	410,251
September 30	371,813	32,903	404,716
October 31	365,833	32,567	398,400
November 30	358,746	32,067	390,813

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Dec. 31.		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	—	—	—
Electrolytic Zinc	—	—	—
Lake George	20,294	1,561	3,059
Mount Isa Mines**	62,781	3,810†	2,448
New Broken Hill	77,050	12,257	17,852
North Broken Hill	—	—	—
Zinc Corp.	85,780	14,215	14,370
Rhodesia Broken Hill*	—	—	—

* 3 Mths. ** Copper 3,695 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	November		December	
	Tons	Oz.	Tons	Oz.
Cam and Motor	25,000	—	—	—
Falcon Mines	20,200	3,848	20,500	3,900
Globe and Phœnix	6,000	2,996	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	3,225	—	—	—
Coronation Syndicate	12,448	—	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	November		December	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	60,064	14,016	60,300	13,928
Ariston Gold Mines	40,070	13,372	40,080	13,047
Ashanti Goldfields	36,000	28,750	36,500	30,550
Bibiani	30,000	7,000	30,000	7,000
Bremang	—	5,556	—	—
Ghana Main Reef	11,366	4,183	12,203	4,254
Konongo	6,700	3,660	6,810	3,706
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1958		1959	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,305	46,553	46,489	18,077
February	43,591	21,313	43,366	19,806
March	43,830	8,179	48,397	17,394
April	46,587	22,573	—	—
May	46,015	19,937	46,423	46,280
June	46,453	20,105	49,995	31,386
July	44,244	19,170	4C,512	32,734
August	47,484	20,549	38,727	29,178
September	48,295	21,141	56,760	33,837
October	46,311	6,342	—	—
November	47,994	16,435	—	—
December	48,888	30,724	—	—

WESTRALIAN GOLD PRODUCTION

	1957	1958	1959
	Oz.	Oz.	Oz.
January	106,722	66,562	63,924
February	64,949	65,965	65,035
March	67,121	65,420	65,408
April	66,435	60,855	62.686
May	64,886	64,196	64,184
June	65,142	67,929	74,590
July	74,420	81,106	78,974
August	75,727	68,610	—
September	64,422	68,744	—
October	64,524	70,128	70,427
November	65,700	67,562	68,858
December	66,562	120,106	—
Total	846,610	867,187	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Nov. 10		To Dec. 8	
	Tons	Oz	Tons	Oz.
Central Norseman	14,101	8,024	14,074	7,052
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	40,862	11,696	41,393	12,098
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	34,645	5,659	34,415	4,917
Hill 50*	—	—	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	—	—	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	—	—	—	—
Mount Ida*	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	29,961	7,200	27,677	7,164
Sons of Gwalia	13,476	2,914	12,440	2,794
Mount Morgan	—	5,625	—	8,951

*3 Months

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
July, 1958	750,410	228,960	42,275	7,740,144
August	740,459	218,126	38,940	7,355,406
September	771,115	202,798	31,543	7,006,517
October	801,965	209,006	34,914	7,178,218
November	783,065	230,251	35,097	7,842,435
December	787,573	219,351	30,989	7,490,094
January, 1959	799.178	227,656	41,277	7,700,672
February	727,843	227,981	32.976	7,798,523
March	807,952	223,728	33.045	7,616,425
April	776,583	225,027	32.778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	774,749	221,814	32,172	7,498,030
August	683,819	191,598	29,141	6,428,545
September	754,208	213,772	34,139	7,116,556
October	794,030	227,192	34,733	7,558,567

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Nov.		Dec.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	—	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	—	—	—
Emperor Mines (Fiji)*	—	—	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	—	—	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	37,185	—	34,104
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	4,220	1,132	—	—
St. John d'el Rey (Brazil)	—	—	—	—
Yukon Consol.	—	$100,000	—	—

* 3 Months. † Oz. Silver: Copper, 100½ : 95½ tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Oct.	Nov.	Dec
Ampat Tin	41	52½	52
Austral Amalgamated	—	—	—
Ayer Hitam	—	—	—
Batu Selangor	—	—	—
Berjuntai	186	199	167
Chenderiang	—	—	—
Gopeng Consolidated	—	—	—
Hongkong Tin	—	—	—
Idris Hydraulic	—	—	—
Ipoh	—	—	—
Jelapang Tin	—	—	—
Kampong Lanjut	83	94	98
Kamunting	93½	100	102
Kent (F.M.S.)	—	—	—
Kepong	—	—	—
Killinghall	—	—	—
Kinta Kellas	—	21½	—
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	24	62	78
Kuala Kampar	54	94	68
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	66	87	142½
Malayan	—	—	—
Malaysiam	12½	5	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	—	465½*
Pengkalen	—	—	—
Petaling Tin	—	—	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	—	—
Rantau	38½	45	57
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	—
Selayang	—	—	—
Siamese Tin Syndicate (Malaya)	33	32	—
Southern Kinta	161	262	298
Southern Malayan	—	—	—
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping Consolidated	6½	—	—
Tambah	—	—	—
Tanjong	—	—	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	—	—
Tongkah Compound	—	—	—
Tongkah Harbour	30	48	44½
Tronoh	—	—	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	Nov.		Dec.	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	200	—	276	—
Anglo-Burma Tin *	16	—	—	—
Bangrin	49	—	37	—
Beralt	8	171†	6	157†
Bisichi	42	39½	40	37½
Ex-Lands Nigeria	41	—	38	—
Geevor	50	—	—	—
Gold and Base Metal	—	—	65	7
Jantar Nigeria	14½	18½	14½	17
Jos Tin	10½	—	—	—
Kaduna Prospectors	5	—	5	—
Kaduna Syndicate	20½	—	22½	—
Katu Tin	30	—	25	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	10	—	—	—
Naraguta Karama	9	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	19	2	—	—
Siamese Tin Syndicate	59	—	83	—
South Bukeru	—	—	—	—
South Crofty	72	—	74	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	—	—	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

October, 1959

Gold	1,754,127 oz.
Silver	179,222 oz.
Diamonds	353,121 carats.*
Coal	3,515,056 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 3,049 tons of 99·20%.
Tin	tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,065 tons.
Chrome Ore	67,604 tons.
Manganese Ore	96,982 tons.
Lead Concs.	51 tons.

* *September, 1959.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		Oct	Nov.
Iron Ore	tons	1,300,321	1,363,488
Manganese Ore	,,	38,146	15,692
Iron and Steel	,,	51,651	74,003
Iron Pyrites	,,	34,931	4,075
Copper Metal	,,	37,023	33,957
Tin Ore	,,	6,712	6,792
Tin Metal	,,	—	45
Lead	,,	10,903	7,551
Zinc Ore and Conc.	,,	26,535	15,547
Zinc	,,	12,100	14,707
Tungsten Ores	,,	603	536
Chrome Ore	,,	10,843	18,302
Bauxite	,,	28,745	37,756
Antimony Ore and Concs.	,,	1,200	1,257
Titanium Ore	,,	10,481	18,414
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	49	52
Sulphur	,,	32,997	20,560
Barytes	,,	4,084	2,938
Asbestos	,,	12,577	11,900
Magnesite	,,	1,210	1,317
Mica	,,	448	723
Graphite	,,	733	709
Mineral Phosphates	,,	62,327	75,849
Molybdenum Ore	,,	687	422
Nickel	cwt.	137,780	132,028
Aluminium	,,	575,818	467,737
Mercury	lb.	216,542	146,727
Bismuth	,,	73,692	70,846
Cadmium	,,	182,005	198,896
Cobalt and Cobalt Alloys	,,	241,442	15,305
Selenium	,,	12,456	26,197
Petroleum Motor Spirit	1,000 gals.	69,531	77,365
Crude	,,	814,002	843,597

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	0	0
Boric Acid, Comml.	,,	77	0	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2½
Citric Acid	per cwt.	9	15	0
Copper Sulphate	per ton	78	15	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		7	0
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Carbonate, white	,,	117	10	0
,, Nitrate	,,	116	15	0
,, Oxide, Litharge	,,	107	15	0
,, Red	,,	105	15	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	56	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2½
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride	,,	21	0	0
,, Iodide	per lb.		6	10
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	198	0	0
,, Sulphate, 50%	,,	20	13	0
Sodium Acetate	,,	75	10	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	10	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	15	0
,, Chlorate	,,	91	0	0
,, Cyanide 100% NaCN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	2	15	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	11	10	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	14	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	7	0	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	126	0	0
,, Oxide	,,	110	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Dec. 8, 1959 £ s. d.	Jan. 8, 1960 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	4 15 0	4 13 9
Blyvooruitzicht (2s. 6d.)	1 10 9	1 9 6
Brakpan (5s.)	6 0	5 3
Buffelsfontein (10s.)	2 7 6	2 10 6
City Deep	1 3 0	1 1 6
Consolidated Main Reef	1 0 6	18 9
Crown Mines (10s.)	1 9 3	1 8 6
Daggafontein (5s.)	1 6 9	1 5 3
Dominion Reefs (5s.)	14 0	12 6
Doornfontein (10s.)	1 15 3	1 14 0
Durban Roodepoort Deep (10s.)	1 18 0	2 0 6
East Champ d'Or (2s. 6d.)	2 3	2 3
East Daggafontein (10s.)	10 3	10 0
East Geduld (4s.)	1 6 0	1 5 0
East Rand Ext. (5s.)	1 9 0	1 7 0
East Rand Proprietary (10s.)	2 4 3	2 3 3
Freddies Consol.	2 9	2 9
Free State Dev. (5s.)	5 9	8 9
Free State Geduld (5s.)	9 12 6	9 9 0
Free State Saaiplaas (10s.)	1 0 9	1 0 3
Geduld	4 2 6	3 17 6
Government Gold Mining Areas (3d.)	3 9	3 6
Grootvlei (5s.)	1 4 6	1 4 3
Harmony (5s.)	1 18 3	1 19 3
Hartebeestfontein (10s.)	2 19 0	2 16 0
Libanon (10s.)	16 0	16 9
Loraine (10s.)	1 16 0	1 17 6
Luipaards Vlei (2s.)	8 9	18 3
Marievale (10s.)	1 10 3	1 9 3
Merriespruit (5s.)	2 3	2 6
Modderfontein B (3d.)	2 6	2 3
Modderfontein East	17 0	16 3
New Kleinfontein	5 6	5 6
New Pioneer (5s.)	1 17 3	1 19 3
New State Areas (15s. 6d.)	1 3	1 3
President Brand (5s.)	3 16 3	3 18 6
President Steyn (5s.)	1 10 9	1 10 3
Rand Leases (9s. 3d.)	8 6	7 6
Randfontein	1 1 3	19 9
Rietfontein (3s.)	5 0	4 6
Robinson Deep (5s. 6d.)	6 9	6 3
Rose Deep (3s. 6d.)	10 0	9 6
St. Helena (10s.)	4 0 6	3 18 0
Simmer and Jack (1s. 6d.)	2 0	2 0
South African Land (3s. 6d.)	16 3	15 9
Springs (5d.)	2 3	1 9
Stilfontein (5s.)	1 17 6	2 1 3
Sub Nigel (3d.)	12 9	11 9
Vaal Reefs (5s.)	2 7 6	2 8 9
Van Dyk (3d.)	4 6	4 3
Venterspost (10s.)	1 3 0	1 2 9
Virginia (5s.)	5 6	5 3
Vlakfontein (10s.)	1 0 6	19 9
Vogelstruisbult (3d.)	7 9	6 9
Welkom (5s.)	1 0 9	1 3 6
West Driefontein (10s.)	9 15 0	10 2 6
West Rand Consolidated (10s.)	1 1 3	1 1 9
West Witwatersrand Areas (2s. 6d.)	4 4 9	4 6 9
Western Holdings (5s.)	8 3 0	9 1 9
Western Reefs (5s.)	1 11 3	1 11 3
Winkelhaak (10s.)	1 5 6	1 6 6
Witwatersrand Nigel (2s. 6d.)	1 3	1 6
Zandpan (10s.)	17 9	18 6
RHODESIA:		
Cam and Motor (2s. 6d.)	10 6	10 6
Chicago-Gaika (10s.)	1 2 6	1 5 0
Coronation (2s. 6d.)	6 0	6 6
Falcon (5s.)	11 9	12 0
Globe and Phœnix (5s.)	1 16 0	2 1 3
Motapa (5s.)	1 0	9
GOLD COAST:		
Amalgamated Banket (3s.)	1 9	1 9
Ariston Gold (2s. 6d.)	5 3	5 3
Ashanti Goldfields (4s.)	1 4 0	1 4 6
Bibiani (4s.)	3 9	4 3
Bremang Gold Dredging (5s.)	3 6	3 6
Ghana Main Reef (5s.)	3 3	3 9
Konongo (2s.)	1 9	1 9
Kwahu (2s.)	6 6	6 9
Offin River (2s. 6d.)	3 9	3 9
Western Selection (5s.)	6 3	6 0
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 6	1 6
Gold Mines of Kalgoorlie (10s.)	8 6	8 3
Great Boulder Propriet'y (2s.), W.A.	12 6	12 3
Lake View and Star (4s.), W.A.	1 9 6	1 9 0
Mount Morgan (10s.), Q.	16 6	18 6
New Guinea Gold (4s. 3d.)	1 6	1 9
North Kalgurli (1912) (2s.), W.A.	10 6	10 0
Sons of Gwalia (10s.), W.A.	2 9	2 9
Western Mining (5s.), W.A.	10 6	10 0

	Dec. 8, 1959 £ s. d.	Jan. 8, 1960 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 11 3	1 11 3
Kentan Gold Areas	1 18 9	1 18 9
St. John d'el Rey, Brazil	3 5 0	3 15 0
Yukon Consolidated ($1)	5 3	8 3
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	1 7 9	1 7 6
Esperanza (2s. 6d.), Cyprus	2 3	2 10
Indian (2s.)	4 9	4 9
MTD (Mangula) (5s.)	12 3	12 9
Messina (5s.), Transvaal	6 10 0	7 3 9
Mount Lyell, Tasmania	1 17 6	1 12 6
Nchanga Consolidated, N. Rhodesia	3 13 6	3 15 9
Rhokana Corporation, N. Rhodesia	37 0 0	3 4 6
Roan Antelope (5s.), N. Rhodesia	9 0	8 6
Tanganyika Concessions (10s.)	2 8 6	2 7 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	12 3	12 9
Burma Mines (3s. 6d.)	2 3	2 0
Consol. Zinc Corp. Ord.	3 13 9	3 15 6
Lake George (5s.), N.S.W.	4 6	4 3
Mount Isa, Queensland (5s. Aust.)	2 15 0	2 15 0
New Broken Hill (5s.), N.S.W.	1 19 0	2 1 0
North Broken Hill (5s.), N.S.W.	5 10 0	5 12 6
Rhodesia Broken Hill (5s.)	10 6	12 0
San Francisco (10s.), Mexico	1 0 6	1 0 9
TIN:		
Amalgamated Tin (5s.), Nigeria	10 3	9 9
Ampat (4s.), Malaya	13 6	12 6
Ayer Hitam (5s.), Malaya	3 1 3	2 19 0
Beralt (5s.), Portugal	1 12 6	1 14 0
Bisichi (2s. 6d.), Nigeria	5 3	5 9
Ex-Lands (2s.), Nigeria	2 9	2 9
Geevor (5s.), Cornwall	1 3 0	1 1 3
Gold Base Metals (2s. 6d.), Nigeria	1 9	2 0
Hongkong (5s.), Malaya	6 3	5 9
Jantar Nigeria (3s.)	4 6	4 6
Kaduna Syndicate (2s.), Nigeria	2 6	2 6
Kamunting (5s.), Malaya	17 3	15 9
Malayan Tin Dredging (5s.)	1 18 3	18 9
Mawchi Mines (4s.), Burma	1 9	1 9
Naraguta Extended (5s.), Nigeria	1 0	1 2
Pahang (5s.), Malaya	10 0	9 3
Ribon Valley (2s.), Nigeria	—	1 0
Siamese Synd. (5s.)	10 0	10 6
South Crofty (5s.), Cornwall	6 3	6 3
Southern Kinta (5s.), Malaya	1 11 0	1 10 9
Southern Malayan (5s.)	1 1 6	18 6
Southern Tronoh (5s.), Malaya	14 6	13 6
Sungei Besi (4s.), Malaya	1 0 3	1 1 3
Sungei Kinta, Malaya	17 6	17 0
Tekka (12s. 6d.), Malaya	5 6	6 9
Tronoh (5s.), Malaya	1 12 6	1 10 3
DIAMONDS:		
Anglo American Investment	15 15 0	16 12 6
Consol African Selection Trust (5s.)	1 4 9	1 6 0
Consolidated of S.W.A. Pref. (10s.)	11 6	11 3
De Beers Deferred (5s.)	9 1 3	9 13 0
FINANCE, Etc.		
African & European (10s.)	4 6 6	4 6 9
Anglo American Corporation (10s.)	10 3 3	10 17 3
Anglo Transvaal 'A' (5s.)	2 9 0	2 11 0
British South Africa (15s.)	5 11 3	5 13 9
British Tin Investment (10s.)	1 6 6	1 7 3
Broken Hill Proprietary	2 17 6	3 0 6
Camp Bird (10s.)	14 6	11 0
Central Mining	4 12 6	4 16 3
Central Provinces Manganese (10s.)	1 10 0	1 12 6
Consolidated Gold Fields	4 15 6	4 19 6
Consolidated Mines Selection (10s.)	2 9 0	2 10 9
Corner House	1 3 0	1 2 9
East Rand Consolidated (5s.)	2 0	2 9
Free State Development (5s.)	5 9	8 9
General Exploration O.F.S. (2s. 6d.)	7 0	6 6
General Mining and Finance	7 0 0	7 3 3
Hendersons (4s.)	14 0	15 0
Johannesburg Consolidated	3 16 9	4 0 0
London & Rhod. M. & L. (5s.)	8 0	8 9
London Tin Corporation (4s.)	12 0	11 0
Lydenburg Est. (5s.)	18 9	18 3
Marsman Investments (10s.)	2 9	2 9
National Mining	2 6	3 0
Rand Mines (5s.)	5 1 6	5 3 9
Rand Selection (5s.)	3 0 9	3 7 6
Rhodesian Anglo American (10s.)	4 12 6	4 1 3
Rhodesian Corporation (5s.)	3 9	3 9
Rhodesian Selection Trust (5s.)	15 3	15 9
Rio Tinto (10s.)	2 5 9	2 8 6
Selection Trust (10s.)	6 6 0	6 3 9
South West Africa Co. (3s. 4d.)	18 9	18 9
Union Corporation (2s. 6d.)	3 18 6	4 6 0
Vereeniging	6 12 6	6 17 4
West Rand Inv. Trust (10s.)	3 9 0	3 15 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Heavy Minerals from Natal Beach Sands

An account of "The Development and Commissioning of the Heavy Minerals Separation Plant at Umgababa, South Coast, Natal" is given by I. F. Cairns and G. Langton in a paper appearing in the *Journal* of the South African Institute of Mining and Metallurgy for November. After a description of the geology of the area and the research that led to the design of the plant the authors say that opening up of the ore-body was not started until the main conveyor to the plant, passing under the National Road and over the railway line, had been installed and until the wet-concentration section of the plant was ready for operation. Starting at the main conveyor to the plant, to the west of the road, a block of ground 150 ft. wide and stretching northwards parallel to the National Road for 800 ft. was excavated from Ilmenite Hill. The mining equipment consists of two rotary bucket excavators of German design, each operating with two stacker conveyors and a D. 7 bulldozer. Each excavator has a rated capacity of 200 tons/hour. As the initial cut proceeded northwards a conveyor-belt was laid parallel with the main road. About 750 ft. of this strike belt was assembled. A dip conveyor was then established from the top of the hill to deliver on to the tail end of the strike conveyor which in turn transfers on to the plant feed belt. The excavators were then moved to the top of the hill.

The method of mining adopted is to remove successive 17-ft. horizontal cuts from the top of the hill downwards. At the start of a cut, either north or south of the dip conveyor, a rotary bucket excavator opens up a 17-ft. deep slot at right angles to the dip conveyor to a limit determined by the length of the stackers operating with the machine. The stackers deliver the mined ore to the dip conveyor through a portable hopper. A lateral strike conveyor is then assembled in the slot and the excavator opens up the slot at right angles to this conveyor. The strike conveyor is extended and moved at right angles to the dip conveyor until the ore on that horizon is mined when the process is started over again at a level 17 ft. below.

The rotary bucket excavator machines operate well in sandy soil, but in the tough clay banks capacity is greatly reduced and maintenance on the machines is high. The possibility of replacing the present mining method by hydraulicing and pumping the ore to the plant is being studied.

A 1,000-ton storage bin was included in the circuit to provide a three-hour surge capacity between mining and concentration. The moist clayey ore, however, forms a hard compact mass after a few hours standing and all attempts to operate with a full bin have been unsuccessful. As the ore has an angle of repose of 90° each section of the bin consists of nothing more than a hole about 2 ft. in diameter from the top of the bin to the discharge door. As a result the Telsmith scrubber has to handle whatever tonnage comes from the mine. Its capacity, however, is extremely flexible and it has, on occasion, handled more than 500 tons/hour without overloading the motor, but the retention time has been proportionately reduced.

On a good sandy feed a Telsmith scrubber does an excellent job and the only trash screen reject product is calcrete nodules, grass roots, etc. However, when clay predominates in the feed the scrubber rejects spherical clay balls up to about 1 in. diameter. These plastic clay lumps contain mineral and constitute a loss in recovery. It has been found that on soaking for a period of about 20 minutes in water these balls disintegrate. A log-washer will be tried ahead of the classifier. If this is successful the classifier overflow will be returned to the trash-screen undersize. The classifier rake product will be screened, the oversize rejected, and the screen undersize containing most of the mineral will join the classifier overflow.

Because of wide variation in the clay content of the feed the cyclones have to cater for the removal of a wide range of *minus* 200-mesh slime. To reduce the slime reporting with the moisture in the spigot discharges three 1-in. water jets have been fitted tangentially to the lowest section of the cyclones. This improves the position but the vortex fraction to the slime dam carries more of the *plus* 200 sand fraction without, however, materially affecting the amount of heavy mineral being carried over. This has remained more or less constant at about 1% of the heavy mineral content of the feed.

The material goes then to a spiral plant the operation of which has at no time presented any difficulty. Density control from the jet sumps is simple and effective and the number of spiral banks in operation is adjusted to suit the incoming feed. Rate of feed is governed by the grade of ore and in high-grade areas the feed has to be reduced below the rated 300 tons/hour to prevent overloading of the cleaners and recleaners. On low-grade ore, however, the plant has handled up to 450 tons/hour with only slightly reduced efficiency. Some difficulty has been experienced in maintaining a valuable mineral content of 80% in the final concentrate when the ore has a high pyrobole content. In general the pyrobole content of the clays is low, while that

of the sands is high. When treating a high proportion of sandy material the coarse predominant pyroboles tend to report with the spiral concentrate and any attempt to maintain too high a valuable mineral concentrate results in high rutile losses.

When the plant was designed it was anticipated that complete removal of magnetite would be accomplished by the rotating-field permanent magnets in the dry section. These, however, removed only about 35% and to overcome this a Dings drum-type wet magnetic separator was installed ahead of the first classifier in the scrubbing and dewatering sections. This unit effectively removes 80% of the magnetite.

Initially eight 10-cu. ft. Wemco attrition units were installed, based on the batch operation of the machine in the old plant. However, in the series machines it was found that due to the vortex formed useful capacity was reduced very considerably. Four additional units were installed giving two lines of six machines. Impeller diameters are being reduced to decrease the vortex and ensure that the percentage solids in the pulp need not be dropped below 85%. Moisture content is governed by the amperage drawn by the attrition unit motors. It is hoped to convert the present manual control to automatic. The final dewatered concentrate to the storage pile carries 12–14% moisture. Provided that 48 hours' drainage time is allowed, and the concentrate is turned once, final moisture drops to 6–8%. The covered storage pile has a capacity of 2,500 tons.

The major mechanical troubles experienced during start-up of the dry plant were with the Dorr Fluo-Solids drier. Such a unit has operated very successfully as a drier on many other products but this was its first application on drying a fine heavy mineral concentrate. Finally, a simple screw feeder of large diameter and slow variable speed was installed and has operated without trouble ever since. The screw casing projects into the drier, while the screw itself is about 18 in. shorter than the casing. A solid plug of concentrate is thus formed between the end of the screw and the discharge and this forms a good gas seal. The screw is carried on a 4-in. shaft supported on two outboard bearings.

The high-tension circuit was set according to results obtained in a Carpco pilot plant and after adjustment when the plant was in operation a highly satisfactory separation was made. Two months later a sudden change in the separation became apparent and excessive pinning of the conducting minerals decreased the efficiency of the separation and large circulating loads of middlings filled up the plant. In the cleaner circuit the pinned fraction increased from 15% to 60% and the new feed rate to the dry plant had to be drastically reduced.

Laboratory high-tension separator tests on the product from the drier confirmed the plant results, but if the feed to the drier was dried and heated in a laboratory oven or over a gas flame normal good separation was obtained. It appeared that some reaction between the drier gases and the mineral particles was causing the refractory effect. At first the fuel oil was suspected and the plant was switched back to a supply of the original oil still held in storage. This was ineffective and the drier was then operated on " dieseline " but the reduced sulphur content of this fuel did not help. It has since been established that the pinning of conductors in the plant is due to a combined effect of surface coatings on the mineral grains and the reaction of combustion gases. Mineral coatings are more tenacious in some sections of the Hill than in others and in the worst case the attritioning units are unable to remove these coatings completely.

Mechanically it is not easy to incorporate more attritioning units in the circuit and so the high-tension circuits were adjusted to meet the worst condition. It was found necessary to increase the speed of the high-tension rolls on the roughers, cleaners, and scavengers in the initial separation—in other words, centrifugal force was utilized to help overcome the pinning effect. The speed of the cleaner rolls was increased from 120 r.p.m. to 240 r.p.m. Since the speeding up of the rolls was introduced the products of the initial separation are not as good as those obtained in the pilot-plant runs or during the first two months of operation and the remainder of the plant has had to be adjusted to operate on these lower-grade products.

The ilmenite magnets were seriously affected by the poor magnetite removal in the rotating-field scalping units. The installation of the wet Dings type separator greatly improved their operation, but anticipated ilmenite recovery was still low. Even the small amount of magnetite still escaping the scalpers built up on the brushes and carried round on the rolls, masking the points of high intensity of the roll surfaces, thereby decreasing their capacity. Increasing the pressure on the brushes did not improve matters but only shortened brush life. In an attempt to improve brush life one was made up using brass bristles. The first brass bristle brush installed only just touched the roll but removed the magnetite completely, design capacity was attained, and the magnetite problem was solved. It is considered that some induced magnetism is set up by the conducting bristles and the field is of opposite polarity to that on the roll and in this way the magnetite is released. With the fitting of brass brushes to all magnets ilmenite recovery improved from 75% to over 90%.

In the final rutile circuit it was at first found almost impossible to produce a *plus* 95% TiO_2 rutile except at very low efficiencies. The pure rutile mineral at Umgababa contains only 97% TiO_2, so only a very low level of impurity can be tolerated in the final product. It was found that in its passage through the multi-stage magnetic circuit and bucket elevators the concentrate temperature had dropped too low for efficient separation in the final rutile high-tension circuit. A 2-ft. diameter all-steel FluoSolids heater was made up and mounted over the rutile high-tension circuit. Hot fluidizing gas was drawn from the combustion chamber of the main drier and good high-tension separation was obtained.

Two other problems remained in this circuit and had to be overcome. Coarse pyrobole particles, which by virtue of their size overcame both the high-tension and magnetic forces and ended up in the rutile, had to be eliminated. A small 80-mesh vibrating screen was installed and eliminated these. Lastly, the slightly magnetic rutile-ilmenite intergrowths which were not removed by the high-intensity magnets were concentrated in the rutile cleaner-thrown product, since they are better conductors than rutile. To remove these from the final product two high-intensity magnets were installed to treat the finished rutile before bagging.

Initially the zircon recovery circuit had to be run at low efficiency as the air flow rates in the Ruggles-

Coles drier had been underestimated and the full tonnage of table concentrate could not be dried. This meant cutting valuable mineral to waste. The fire box of the drier was redesigned and a larger fan installed and recovery improved. When the pinning trouble became bad in the primary high-tension separation the rutile content of the scavenge-pinned product was high and the TiO_2 content of the finished zircon could not be held below 0·25%. Again it became necessary to set the cutters on the table well into the zircon band to reduce the rutile content of the feed to the zircon high-tension circuit. After speeding up all the high-tension rolls it has been possible to operate with high zircon recovery.

The monazite in the feed all ends up in the magnetic reject fraction from the zircon high-intensity magnets and a typical analysis of this product is garnet-pyrobole 51·6%, zircon 32·7%, and monazite 15·7%. This product is stockpiled and the circuit was so designed that it could be re-treated through the zircon treatment plant once a week. This was tried on two occasions and an unexpected complication became apparent which made it impracticable to produce *plus* 95% monazite at acceptable efficiencies. The zircon in this product, due to inclusions of ilmenite and heavy iron staining, has a magnetic susceptibility almost exactly the same as the monazite and separation of the two minerals by magnetic means is difficult at reasonable efficiences. Experiments are at present being carried out at the mine with an air table. If these are successful the inclusion of this unit in the circuit will allow monazite to be recovered currently.

Bead Test for Uranium

In the *Mining World* of San Francisco for December there is a description of a fast, inexpensive, and sufficiently accurate visual bead test developed to determine the U_3O_8 content of ion-exchange tailing in a uranium mill. It is expensive, it is stated, to staff and operate a standard fluorimetric laboratory to maintain mill control of tailing. The time necessary to make such a determination is so long that an appreciable uranium loss to tailing can result while awaiting assay results.

Management at the Monticello, Utah, mill operated by the National Lead Company, Inc., for the United States Atomic Energy Commission has developed this quick-on-the-spot assaying method for mill operators who have no knowledge of chemistry. In weak solutions, 0·01 to 0·05 g. of U_3O_8 per litre, the method is accurate enough for mill control.

Equipment Required to Make Tests

1 burner (high temperature).
1 dozen platinum inoculating loops, about 3 or 4 mm. in diameter.
1 ultra-violet light source.
1 dark room approximately 4 ft. wide, 3 ft. deep and 7 ft. high.
2 plastic bell jars.
1 dozen metal holders for platinum inoculating loops.
2 stands or wooden blocks with sufficient holes in each to handle six of the platinum holders and small enough to fit under a bell jar.
1 spot plate.
1 pellet maker (adjustable).
12 dropper bottles 100 ml. capacity, (glass top).
" Alconox " cleaner.
Sodium fluoride, 98%, mixed with lithium fluoride, 2% (Flux).
1 to 1 mixture of sulphuric and nitric acids. (Cleaning solution for platinum loops.)
Separan, 1·0%.
Concentrated H_2SO_4.
Concentrated HNO_3.
Concentrated " Tergitol " or other suface-tension reducer.

Bead Test. To the tailing sample add two or three drops of Separan, shake, and let settle. Pour about 25 ml. of the sample into dropper bottle. Then add six drops of concentrated nitric acid, and one drop of " Tergitol ", and shake the bottle.

A pellet of flux is placed in the depression of a clean spot plate. A clean platinum loop is heated to redness and the pellet is scooped upon the hot wire. Loosen the top of dropper bottle slightly and turn to " off " position. Tip up and let half a dozen drops fall ; then, with the flux tablet directly under the glass dropper, catch a drop just as it leaves the dropper.

Dry tablet above the flame, being careful not to dry it too fast. When the flux has become white again melt in the upper portion of the blue flame until bead is clear.

Let bead cool and then read. Compare the sample with a set of standards under ultra-violet light. Standards are prepared in the same manner as above and kept under a plastic bell jar.

In order to bring about reproducible results the most important factor is the standardization of conditions—that is, the samples should be fused for the same length of time and under the same conditions as the standards. Fusion over a reducing flame decreases the fluorescence by as much as 20%. Cooling slowly increases fluorescence. At least one minute should be allowed to accustom the reader's eyes to darkness after entering the dark room. Goggles with filter to transmit 520–640 μ radiation, if used, increase reliability. " Tergitol " is used to decrease surface tension by giving a smaller and more consistent drop on the pellet.

In the mill it was found that there was considerable quenching of fluorescence by contaminants in solution. This quenching was caused by iron, chromium, copper, calcium, silicon, vanadium, aluminum, and sulphates, while columbium, tantalum, and other rare elements cause the emitted fluorescent light to increase.

Therefore, the standards had to be made using the same solutions that are used in the bead test. These standards are prepared with values of 0·005, 0·01, 0·02, 0·03, 0·04, and 0·05 grams. U_3O_8 per litre. The use of a few drops of concentrated nitric acid added at this point tends to alleviate the quenching difficulty. The standard beads become contaminated from yellow cake and dust and lose their fluorescence, so that new standard beads are necessary periodically.

When the bead tests were inaugurated it was hoped that the accuracy would be within *plus* or

minus 0·01 grams. U_3O_8 per litre. However, the operators have been able to interpolate the value between each standard and give a better-than-average result when comparing the bead test with the fluorimetric method of analysis. In practice the operators consistently estimate results within *plus* or *minus* 0·003 of the fluorimetric results.

When the concentration of U_3O_8 exceeds 0·05 g. U_3O_8 per litre the beads cannot be compared with the standards, even though higher standards could be prepared. This limit is due to the difference in fluorescence which is not sufficiently apparent to the human eye so as to make an accurate estimate of the value.

The first platinum loops were made out of stock wire by the analytical laboratory and set into glass tubing for use as a holder. Duplicating the loop diameters and the shaking done to remove the flux when cleaning the loop created a condition of high loss of platinum. Then prepared platinum inoculating loops were purchased and small metal chucks to hold the wire.

The prepared platinum loops are holding up under usage. The metal chucks are failing because they freeze and cannot be broken loose for installation of a new loop. Forcing the chuck to open results in breaking the holder just below the chuck and subsequent replacement is necessary.

When the platinum loop is badly contaminated it is cleaned by a mixture of nitric and sulphuric acid followed by a water rinse.

All glassware should be washed with a cleaner such as "Alconox", having no background of fluoresence. Dust containing any form of uranium should be avoided and the flux should be checked often for the contamination by running a blank at least once a shift.

Iron Ore in Ungava

An account of progress in the operations of the Ungava Iron Ores Company is given by C. E. White in the *Western Miner and Oil Review* for November last. For the past nine years exploration by the company has been carried out and a large tonnage of good concentrating ore outlined in its Atlantic concession.

The area lies in the Quebec-Labrador iron belt, commonly referred to as the Labrador Trough. This extends from Mt. Reed, 200 miles south of Schefferville, to the vicinity of Hudson Strait, a total distance of 600 miles. The Trough is an elongated geosynclinal basin in the Archean Complex, which was filled by a thick series of clastic sediments. The upper part of these is interlayered and overlain by a volcanic series which is in turn intruded by abundant sills and dykes of basic igneous rocks. In numerous places, especially in the central and eastern part of the Trough, there are acidic rocks cutting across the older formations.

The iron series, referred to as the Sokoman formation, occurs in the lower part of the sedimentary series and is best exposed in the western half of the Trough. The base of the iron formation is usually separated from the Archean Complex by a few hundred feet of schist and quartzite. In the Ungava region the iron formation outcrops almost continuously on the western side of the Ungava Bay. It has been followed from Leaf Bay northward as far as Roberts Lake; at all points it is within 20 or 25 miles of tidewater. The bulk of the ore reserves is located where local irregularities and folding affected the iron formation. The metallic-iron formation is underlain by a silicate-iron formation and overlain by a carbonate-iron formation. The ore can vary from almost pure magnetite to pure haematite with all variations in between. The beds vary in thickness from 100 ft. to over 300 ft. and the economic portion has a soluble iron content of over 30%. Objectionable impurities such as phosphorus, sulphur and titania (TiO_2) are very low—less than 0·02%.

Diamond drilling has proved an ore reserve in the Atlantic concession of 581,700,000 gross tons averaging 35·7% sol. Fe, with an average stripping ratio of 0·16 cu. yd. per ton of ore. In the far-western portion of the area very little drilling has been carried out and it is reasonable to assume that with further drilling the ultimate tonnage of ore in the Atlantic concession will exceed 1,000,000,000 tons. Preliminary estimates, based on examination of the surface exposures, a limited amount of diamond drilling and surface sampling, and a geological knowledge of the iron formation, indicate that ore reserves in the International concession will also exceed 1,000,000,000 tons, averaging approximately 36% Sol. Fe, with a stripping ratio similar to that in the Atlantic concession.

The Castle Mountain zone has been selected as the site for initial mining operations. A preliminary pit layout indicates that approximately 185,000,000 gross tons of crude ore, averaging 34·9% sol. Fe, can be mined from this zone. A total of 39,000,000 cu. yd. of waste material must be removed from this ore-body, making a stripping ratio of 0·2 cu. yd. per ton of ore.

Mining is to be carried out by conventional open-pit methods, using a 45-ft. bench. Rotary drilling of 9-in. holes will be followed by blasting the ore and loading it, by means of 7-yd. electric shovels, into 27-ton trucks. The average truck haul is estimated to be 4,000 ft. against a maximum grade of 5%. The ore will be dumped from the trucks into 90-ton gondola-type railroad cars for transport to the primary crushing plant at Hopes Advance Bay, a distance of approximately 20 miles. Mining operations have been based on a 330-day year. This will give ample allowance for time lost due to inclement weather and to mechanical and electrical failures.

The determination of the proper beneficiation process to be used for the Ungava project depends upon a number of factors—such as, the analysis of the crude ore; ratio of magnetite to haematite in the ore; grain structure of the ore; desired grade of concentrate to be produced; ratio of concentration to be obtained; per cent. iron recovery to be

obtained; desired method of agglomeration to be used; capital costs of the beneficiation plant, and operating costs per ton of plant product.

The grain size of the magnetite and haematite varies appreciably in the individual ore beds, with the magnetite tending to be finer-grained than the haematite. However, it is important to note that the ore is not nearly as fine-grained as the Minnesota taconites and therefore does not require the same amount of fine grinding. Tests indicate that in general the ore must be ground to approximately 65% through 325 mesh in order to obtain a concentrate of 66% iron or higher, using normal wet-magnetic concentration methods.

Results of laboratory tests have definitely indicated that, due to the relatively fine-grained size of the Ungava ores, gravity methods of concentration do not have sufficient value to warrant further consideration for the beneficiation of these ores.

Laboratory-test results on straight-magnetic concentration—*i.e.*, without magnetic roasting—have not been satisfactory owing to the fact that the high percentage of haematite results in a high tailing loss. On the other hand laboratory and pilot-plant tests, using magnetic roasting followed by wet-magnetic concentration, have shown excellent results, with the concentrate usually analysing 68 to 71% iron and representing iron recoveries of 96 to 98%. These tests have clearly indicated the metallurgical feasibility of magnetic roasting at a relatively coarse size (*minus* ¾ in.), followed by grinding and wet-magnetic concentration, and a detailed study of capital and operating costs has indicated that the use of this combination process is sound from an economic standpoint.

Most of the magnetic-roasting tests have been done by Lurgi at Frankfort/Main in Germany and the concentration tests were done at the Mines Experiment Station, University of Minnesota, in Minneapolis, Minn.

Pelletizing tests have been made by the Allis-Chalmers Manufacturing Company, at their pilot plant at Carrolville, Wisconsin, and by Lurgi, in Germany.

The beneficiation plant consists of 10 rod-mill units each having a capacity of 1,000,000 gross tons of concentrate per year. The normal capacity of the plant will be 30,000 tons of crude ore per day. The coarse-crushing plant will consist of the first- and second-stage crushing and will be housed in a shaft approximately 135 ft. deep. Ore of *minus* 3 in. will be discharged from secondary crushers by an elevating conveyor to the ore-bins. The 4th stage crushers will discharge at *minus* ¾ in. size.

The crushed product will be roasted in the magnetic-roasting plant where the haematite portion of the ore will be converted into magnetite. After roasting the ore will be ground in rod-mills and ball-mills to 65% *minus* 325 mesh. Wet-magnetic separation will then be used, followed by filtering which will produce a filter cake having about 67% iron. Pelletizing will be done in balling drums followed by a straight-grate pelletizing machine. The pellets will have an iron content of about 65% and will be approximately ½-in. diameter.

Trade Paragraphs

Powell Duffryn Technical Services, Ltd., of Boundary House, 7–17, Jewry Street, London, E.C. 3, announce that this is now their address, the telephone number being Royal 0141.

Soil Mechanics, Ltd., of 65, Church Street, London, S.W. 3., have published a booklet on the measurement of pore water pressures in earth dams which describes the use of piezometers during and after embankment construction.

Chaseside Engineering Co., Ltd., of Hertford, announce that they have produced a film to demonstrate their four-wheel drive Loadmaster 800TC to which reference was made in a note in the November issue following a demonstration of this and other new models.

N.C.K. Rapier Sales Co., Ltd., of 32, Victoria Street, London, S.W. 1, have issued a little booklet entitled "How to be a Star Driver." This sets out in a short text, freely interspersed with a number of amusing sketches, all the points that a shovel operator should know.

Allis-Chalmers Manufacturing Co., of Milwaukee, Wisconsin, issue a bulletin giving 21 modern operating advantages of the A-1 jaw-crusher. Nearly 20% longer and some 35% deeper crushing chamber capacity, the crusher's required power is reduced through the use of a longer pitman and front toggle, it is stated.

Babcock and Wilcox, Ltd., of 209 Euston Road, London, N.W. 1, announce that Marion Power Shovel Company excavators and cranes in several models will be manufactured in Scotland at their Dalmuir works, under an agreement made known recently by the President of Universal Marion Corporation. The Marion range covers diesel and electric shovels, cranes, and draglines from ¾ cu. yd. to 70 cu. yd. capacities

Michigan (Great Britain), Ltd., of 3–5, Charles II Street, London, S.W. 1, recently handed over at their Camberley works the 500th British-built machine—the 275-ft. Supertractor—to the Steel Company of Wales. On the occasion the representative of that company emphasized the revolution in handling techniques which has resulted from the availability of large-capacity highly-mobile traction-shovels of this description.

Merton Engineering Co., Ltd., of Feltham, Middlesex, announce that the Merton Frontloader 59, first introduced in June last, is now available with torque converter power-shift transmission, the unit fitted being the Brookhouse hydraulic shift-single stage torque converter, giving two forward and one reverse speeds of up to 5 and 10½ m.p.h. and 5½ m.p.h. respectively. The power unit is the Fordson 4-cylinder 62-h.p. diesel.

Head, Wrightson and Co., Ltd., of 20, Buckingham Gate, London, S.W. 1, issue two leaflets from their associated company Head, Wrightson Colliery Engineering, Ltd. One of these refers to the cyclone washer for mineral concentration at the lower size ranges and the other to the Stripa process developed

in Sweden, for which they are agents. This process is of the dense-media type and was specifically mentioned in the review of mineral dressing progress in the December issue.

Dow Chemical International, Ltd., of Midland, Michigan, announce that the British subsidiary—Dobeckmun Britain, Ltd.—has changed its name to **Dow Chemical Co. (U.K.), Ltd.,** and broadened the scope of its activities. The address of the new company is 48, Charles Street, London, W. 1, and among other activities it will supervise the sales of Dow U.S. and Canadian-produced industrial chemicals, although R. W. Greeff and Co., Ltd., will continue as principal distributors.

English Steel Corporation, Ltd., of Sheffield, in a recently issued illustrated booklet, deal with the Willison automatic coupling for mining and allied industries. The coupler is of the interlocking vertical plane type and the design is such that cars can be reversed without "handing." The rigidity of the automatic coupler pulls the car back to the rails if they tend to stray, it is stated, and even in actual derailment the cars remain upright. It is thus particularly suitable for man-riding cars.

Deister Concentrator Co., of 905, Glasgow Avenue, Fort Wayne, Indiana, in an illustrated leaflet describe their Concenco water-spray nozzles and their application, for example, to the effective washing of materials on a vibrating screen. The single nozzle thread is furnished with a suitable jacket and fastening means and is assembled without tapping and there are no threads to wear out. The means of fitting nozzles to feed pipes are described with the advantages to be obtained.

Simons-Lobnitz, Ltd., of Renfrew, is the new name by which the two well-known dredger specialists, shipbuilders, and engineers, Wm. Simons and Co., Ltd., and Lobnitz and Co., Ltd., will in future be known. , The two companies will continue to serve the needs of their friends everywhere as formerly, strengthened not only through their own integration but through their operation also within the Weir Group of Companies. The management personnel of the two former companies will continue to be available in the combined concern.

Stenor, Ltd., of Richmond, Surrey, issue a leaflet, which describes their conveyor-belt repair system by vulcanizing. The repair kit consists of a Weldbelt vulcanizer and a set of tools and accessories neatly packed in a carrying case. Repairs can be carried out by one man and the system is particularly recommended when the belt is operating in damp or arduous conditions. The Stenor system, which is approved by leading belt manufacturers, makes possible a much simpler method of repairing damage, even holes right through the belt, and of repairing the edges of the belt.

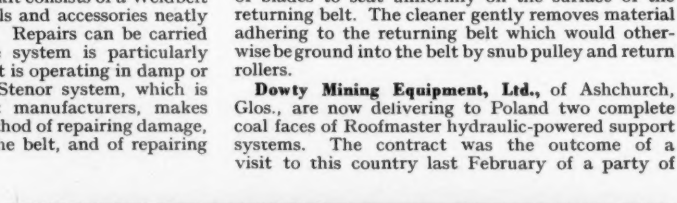
Richard Sutcliffe, Ltd., of Horbury, Wakefield, in some notes on their stable hole conveyor state that this has been designed for the maintenance of stable holes in advance of the coal face and for the reduction of the manpower required to remove coal, etc. at this point. Easily transported it can be used wherever coal or stone has to be moved short distances in confined spaces. The conveyor is designed to use an 18 in. wide belt. It is driven at the tail end by a combined electric motor and drive pulley assembly and at the delivery end by a tensioned return pulley.

Neldco Processes, Ltd., of Crossway House, Bracknell, Berks, issue notes on the Sala personal safety block now available for the first time in England which gives complete security to operators in high places. The block contains 16 ft. of steel-wire rope, spring-loaded, and controlled by a braking device. It can be quickly fixed anywhere and has a locked hook for simple attachment to the workman's safety belt. The workman has completely free movement and the rope is always taut, but in the event of a fall the brake operates and the man is gently brought to a stop within 12 ft. and supported.

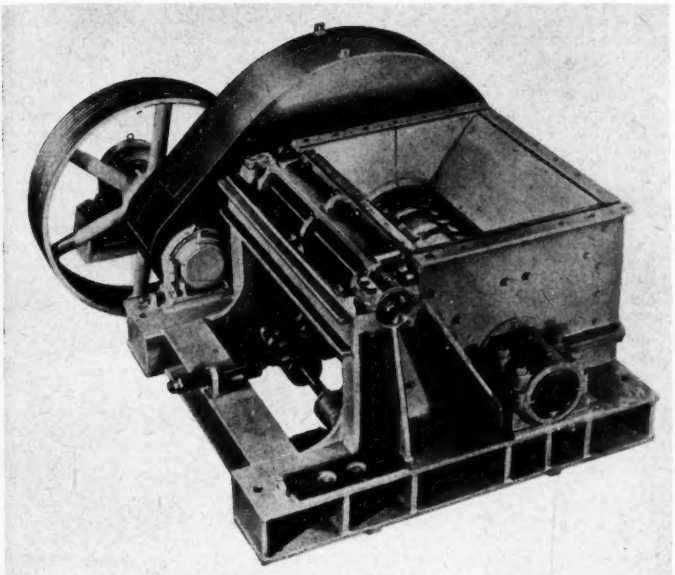
Le Tourneau-Westinghouse Co., of Peoria, Illinois, have issued notes on the most important development in earthmoving equipment in the past ten years. These refer to the introduction of tandem scrapers which are currently available for use with all three sizes of the company's two-wheel Tournapull prime movers, as well as with the recently introduced four-wheel Speedpull. Total capacities with the tendems range from 18 cu. yd. in the D size to 56 cu. yd. in the model B. The L-W tandem system is extremely flexible, coupling or uncoupling the second scraper being easily accomplished in 30 minutes or less. One hitch pin forms the mechanical connexion, while quick connect plug-ins provide the hook up for electric cables and air hoses.

Stephens-Adamson Manufacturing Co., of Aurora, Illinois, in a recent note refer to their S-A spring type belt cleaner originally developed to clean wet sticky coal and ore from high-speed conveyor-belts. The cleaner consists of a row of thin spring-steel wiper blades each with an individual pressure spring. The blades are set perpendicular to the belt surface, but diagonal to travel of belt. Pivoted connexions between blades and springs permit the wiping edges of blades to seat uniformly on the surface of the returning belt. The cleaner gently removes material adhering to the returning belt which would otherwise be ground into the belt by snub pulley and return rollers.

Dowty Mining Equipment, Ltd., of Ashchurch, Glos., are now delivering to Poland two complete coal faces of Roofmaster hydraulic-powered support systems. The contract was the outcome of a visit to this country last February of a party of



Le Tourneau-Westinghouse Tandem Scraper.



Pennsylvania Hercules Single-Roll Crusher.

Polish mining engineers. The name of Dowty Mining was already known in Poland, it is stated, the company having supplied hydraulic pit props to the mining industry there 18 months ago so that when the party showed interest in the Roofmaster system Dowty engineers were invited to survey the Katowice coalfields and advise upon installation and operation. Six Polish engineers are now at the Dowty service centre at Chesterfield receiving instructions on the Roofmaster and seeing it in action in the neighbouring coalfields.

Knapp and Bates, Ltd., of 14–17 Finsbury Court, Finsbury Pavement, London, E.C. 2., announce the introduction of a new range of rod-mills and ball-mills specially designed to meet the needs of the operator who is willing to pay a little more to obtain substantial reductions in operating cost. Mills are offered in 3 ft., 4 ft., 5 ft., and 6 ft. diameters and larger diameters are under active development. The mills feature a number of special advantages :—Rubber-cushioned liners which can be supplied to customers' profile where desired ; totally-enclosed gearbox drive from high-speed motors, with short-centre vee-rope drive to give flexibility in speed modification ; anti-friction trunnion and countershaft bearings ; motors with built-in condenser for power-factor correction, or auto-synchronous motors for larger sizes, and heavy-duty cast-steel mill heads.

Cementation Group of Companies, of 20, Albert Embankment, London, S.E. 11, announce that they are to establish a permanent headquarters for group research at Maple Cross, Rickmansworth, Herts. The new centre will cost approximately £80,000, will house some 50 staff, and will consist of offices and laboratories on two floors with a total area of 18,000 sq. ft. The centre will also accommodate the laboratories of the group's soil mechanics section.

In a separate announcement it is stated that the Cementation Co., Ltd., have formed a Ground Engineering Division comprising two main departments—cementation and geotechnical, the latter being responsible for the activities previously conducted by the company's soil mechanics and vibroflotation sections. This department will also devote particular attention to the development of technical solutions to problems of ground treatment and for this purpose a new section known as Process Design has been formed.

Imperial Chemical Industries, Ltd., of Millbank, London, S.W. 1 refer to ventilation ducting as having an all-important role to play in the day-to-day running of a mine. For some time now various materials have been used in British mines for such ducting including p.v.c.-coated jute, rayon, and cotton fabrics. Recently a bulk order for more than 30 miles of p.v.c.-coated Terylene ventilation ducting (fire-resistant in accordance with N.C.B. requirements) has been placed. This varies in diameter from 12 in. to 24 in. and has been stitched throughout with terylene thread. Made up by **Robert Watson, and Co., Ltd.,** of Newburgh, Fife, from a specially-woven 2½ oz. per sq. yd. twistless base fabric the ducting is about three times lighter than that formerly used. Its use results in easier handling, greater efficiency, and longer life. The lightness of the coated Terylene fabric has found particular favour among the miners themselves, while its very high rot resistance and retention of tear strength are marked advantages where damp conditions prevail.

General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2, announce that Fraser and Chalmers Engineering Works have recently supplied a single-roll crusher, 60 in. wide by 30 in. diameter roll, to Atlantic Gypsum, Ltd., of Corner Brook, Newfoundland, for the reduction of gypsum

rock in their quarry at Flat Bay. The machine, which is made under licence from the Pennsylvania Crusher Co. and is the largest of the new Pennsylvania Hercules medium-duty range, is illustrated here. It is capable of breaking 36 in. lumps of rock down to 5 in. size or under at the rate of 400 tons per hour. The toothed crushing roll is driven at 40 r.p.m. by a 250-h.p. G.E.C. slip-ring motor, running at 700 r.p.m., through V-belts and gears. Both the frame of the crusher and the breaker plate have been designed for all-welded construction and the whole crushing zone is protected with liners of special steel.

A separate note from the company's Engineering Group refers to two contracts for electric winders to the value of £250,000 recently received from South Africa. The winders are for installation at gold mines in the Anglo American group. The first is for the supply of one 10 ft. 6 in. by 6 ft. by 6 ft. 4,500-h.p. Blair-type (twin rope) hoist for President Steyn Gold Mining. The second is for the supply of mechanical parts only of two 12 ft. dia. by 5 ft. wide 1,100-h.p. double-drum hoists for Western Deep Levels, Ltd. These hoists are to be installed underground to serve No. 2 and No. 3 sub-vertical shafts and will be manufactured in South Africa to the designs of the Erith works.

Glass Developments, Ltd., of Sudbourne Road, Brixton Hill, London, S.W. 2, recently made available some notes on automatically-operated mechanical air-sampling equipment designed for the United Kingdom Atomic Energy Authority for monitoring airborne beryllium dust. The equipment is suitable for handling six samples per hour, presenting them to a recording ultra-violet emission spectrometer capable of analysing a liquid solution. The sample is submitted to several processing phases before it is passed to the spark chamber. In operation 100 litres of air are sampled every 10–12 minutes. The range is 0·25 to 25 tolerances (1 tolerance is 2 microgrammes per cubic metre) and readings are presented on a strip chart recorder. The principle of measurement is solution of the dust in sulphuric acid and analysis of this solution with an emission spectrograph. With this method errors due to the chemical state and particle size of the dust are avoided. The monitor will function automatically and continuously for 10-hour periods without any attention. Audible and visible alarms are operated if the beryllium concentration exceeds a pre-set level. Interlocks are incorporated and also operate the alarms.

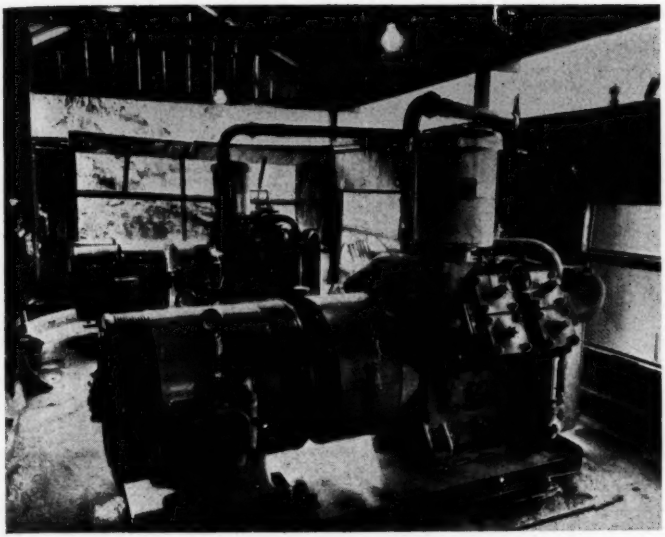
English Electric Co., Ltd., of Stafford, in their annual review of activities for 1959, include some notes on diesel engines for which many orders have been received for both diesel and dual-fuel types. Diesel-alternator sets have been ordered from New Guinea, Iran, Venezuela, Sierra Leone, Nigeria, Ghana, and South and East Africa, while sets have been commissioned at Penang in Malaya and also in Ghana.

Convertors.—Under this heading reference is made to the company's leadership in the mercury-arc convertor field. Equipments with outputs of 1,175, 1,328, and 1,085 kW for mine winder installations have been supplied in Britain and South Africa.

Mining Equipment.—During 1959 the company received orders for the electrical equipment of mine winders for home and overseas and in each case the mechanical equipment has formed part of the order. For a South African mine one notable order covers the supply of a 5,400-h.p. (r.m.s.) Ward-Leonard winder. The 70-r.p.m. direct-coupled motor is to be supplied from two 2,080-kW generators and will wind through the 6,600-ft. shaft at 3,600 ft./min. With the closure of several collieries in the United Kingdom, some of which used English Electric winders, orders have been received for the transfer of these equipments to other more productive pits. In some cases modifications have been requested to bring the equipments in line with revised requirements. During the year winder equipments have been commissioned in Canada, Australia, South Africa, and the United Kingdom. One of the winders commissioned in Canada, for hoisting nickel-copper ore, is operating on automatic control and is referred to in a further note below. The company undertakes on a comprehensive basis the electrical equipment of surface installations in the form of coal-preparation plants, mine-car handling plants, etc. For controlling the sequence starting of the motors for such plants a new multi-panel motor control board has been developed, having either fixed or drawout-type starter units. Drawout-type starter units are embodied in a board that is fully accessible from the front, so saving the normal space required for rear access. A further development of note is a new all-dry type of charger for underground battery locomotives using silicon rectifiers and an air-cooled transformer. This charger retains the controlled charging rate feature of previous equipments but is designed for a higher output.

Welding Equipment and Electrodes.—An outstanding development in 1959 has been the production of a range of portable welding equipments giving outputs of either a.c. or d.c. The unit consists of a transformer, welding regulator, silicon rectifiers, and ancillary gear, completely oil-immersed and mounted in a heavy-gauge steel-plate tank fitted with three rubber-tyred wheels and tow bar. Selection of the required welding supply is simple and is controlled by a three-position switch mounted in an accessible position on top of the set enabling an output of a.c. or d.c. of either polarity to be chosen at will. Equipments are manufactured in three sizes (300 amp., 450 amp., and 600 amp.) and are said to be the first to employ oil-cooled rectifiers. They are robust, can be used as a power supply for inert-gas welding, and have provision for inbuilt power-factor correction. An improved design of welding regulator has been introduced in 1959 and is proving satisfactory in service. Three new welding electrodes have been added to the company's range in 1959. "Manganees" is for the welding of 12–14% manganese steel components. "Herculees 35" is an improved low-hydrogen electrode for high-tensile steels and restrained joints. It is very clean in use and produces a good finish on the weld. "Weldees" is a general-purpose electrode developed for easy welding of mild steel. It can be used with "touch technique" in all positions.

In a separate note the company mention that the installation in 1957 of a 7,000-h.p. vertical Francis water turbine, which doubled the output of the Laurie River hydro plant, Manitoba, has enabled considerable re-organization and expansion to be made at the Lynn Lake nickel-copper mines of Sherritt Gordon, Ltd. The Laurie River plant is the only source of power for the area. At the Lynn Lake mines a new shaft was sunk, with an initial depth of 2,000 ft., and two Ward-Leonard mine winders have just gone into service, the electrical parts of which



English Electric 100-h.p. Motors. Driving compressors in Ma On Shan iron mine, Kowloon.

winders were supplied. Both are of the conventional double-drum type with one fixed and one clutched drum.

The larger winder handles the ore output and operates with balanced bottom-opening skips from four underground levels. The rope speed is 1,560 ft./min. The 700-h.p. winder motor, with a speed of 435 r.p.m., is fed from a motor-generator set consisting of a 575-kW generator coupled to an 800-h.p. 720-r.p.m. induction motor. Push-button automatic control is used. The cage and counterweight service winder is driven by a 450-h.p. 346-r.p.m. motor supplied by a 375-kW generator coupled to a 500-h.p. 720-r.p.m. induction motor. The rope speed is 1,080 ft./min. Because the shaft is to be extended within a few years to a depth of 4,100 ft. provision has been made for a further motor and motor-generator set to be added to each winder The rope speeds will then be increased to 2,040 ft. and 1,500 ft./min. The original winders at Sherritt Gordon, also using English Electric equipment, were supplied almost 30 years ago and are still in service at the older shafts. The mechanical parts of all the winders were supplied by **Fullerton, Hodgart, and Barclay, Ltd.,** of Paisley, the main contractors.

Sturtevant Engineering Co., Ltd., of Southern House, Cannon Street, London, E.C. 4, issue a new publication (No. 7204) devoted to their electrostatic separator. In an introductory note they state that separators employing high-voltage electricity have been in use for many years, but, although possessing certain advantages when compared with other separating devices, the types hitherto available have suffered from two main handicaps ; capacities have been low and efficiency of separation poor. The new Sturtevant type O.H. high-tension electrostatic separator overcomes these objections, it is claimed, and is the outcome of many years experience and research.

The general principles of this type of separation can be described as follows :—The materials to be separated are fed on to a rotating roller, the speed of which will impart a trajectory to the particles. This roller is earthed electrically. Situated in a convenient position is a combination type discharge electrode, which is connected to a unidirectional electricity supply of 20,000 to 50,000 volts. As the particles comprising the mixture pass between the electrode and the roller they receive an electrical charge. The particles with relatively low conductivity will retain their induced charge for an appreciable period of time and will adhere to the roller until removed by means of a special cleaner. This adherence to the roller is generally referred to as " pinning." The particles with a higher surface conductivity will lose their charge quickly and follow their normal trajectory as determined by the rotational speed of the roller. With the aid of adjustable guides the separated fractions can be led to their respective discharge chutes. Practically all separation processes yield a " middling " due to " chatted " particles or unavoidable entanglement of a few particles of one product with those of another. The middling is either returned to the feed, or preferably passed to another separator of which the voltage, speed of roller, and feed rate may be regulated to yield the best results.

The separator has a high capacity and great sensitivity. Three units are available each having two rollers. The largest machine can deal with 10,000 lb. per hour on some materials. The separator is fitted with a distribution box for connexion on the 400–440 volt three-phase mains ; this supplies the roller drive motors, single phase at 200–250 volts being taken to the transforming and high-tension rectifying unit which is incorporated in the plant. The total power consumption is low, approximately 1½ kW on a 2-roller 60-in. machine. A smaller edition of the standard separator is made for laboratory and pilot-scale work.

William H. Capper and Co., Ltd., of 8–9, Hertford Street, London, W. 1, announce that an agreement has recently been made whereby they are appointed sole representatives in the U.K. for the sale of all

products of the compressor division of **Demag, A.G.,** of Duisberg, Germany. These include reciprocating, turbo, axial-flow, and rotary compressors, centrifugal blowers, and a wide range of mining equipment. The agreement covers only a small part of the German company's output of 1,600 different kinds of products and the construction divisions equipped to erect complete steelworks, electro-metallurgical and electro-chemical plants, bridges, and harbours. In order that British companies interested in compressors and mining equipment may obtain swift advantage from the technical resources of the Demag organization experienced engineers have been seconded to work in the London Office.

A separate note issued at the same time gives some details of unusual features in the design of Demag four-stage turbo-compressors which enable them to be built with air intake capacities as low as 5,000 c.f.m. for pressure ratios up to 15 : 1, compared with an intake of 25,000 c.f.m. usually regarded as the minimum for this type of compressor. There are nine machines in the new range, with air inlet capacities from 5,000 to 30,000 c.f.m. They are suitable for every industry in which large quantities of compressed air or nitrogen are required and for installations where compressed-air conveyor systems are used. The efficiency of a multi-stage turbo-compressor is largely dependent on the relationship between the size of its impellers and their driving speeds. When a group of impellers are spaced along a single driving shaft this relationship is correct only for the first stages. Ideally, later-stage impellers should revolve at a faster speed, in order to achieve the same tip speed, as the diameter is reduced to the effective gas or air volume in the later stages. In practice, this is seldom possible, and the overall efficiency of the machine is reduced.

The new Demag machines have four impellers, mounted on two parallel pinion shafts which are driven at two different speeds by a large central gear. The shaft carrying the first and second stage impellers rotates between 9,000 and 12,000 r.p.m., the other at 16,000 to 18,000 r.p.m. By this means optimum impeller speeds are obtainable at all stages and, as a consequence, the number of impellers can be reduced to four. Another feature helping to increase impeller efficiency is the large unobstructed air inlet to each. On single-shaft machines the space available for air inlets is considerably reduced by the presence of the shaft; on the four-stage compressor the impellers are mounted at each end of each driving pinion and overhang them so that there is no driving shaft to interfere with air intake. The placing of the gear between the two pairs of impellers, and the reduction of the number of impellers to four, saves space and weight. It also allows the machine to be delivered and installed as one unit. As the machine is virtually vibration free foundations and basement can be of a much lighter construction.

RECENT PATENTS PUBLISHED

☛ **A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London W.C. 2, with a note of the number and year of the patent.**

9,461 of 1956 (824,298). UNION CARBIDE CORPORATION. Process for the production of refractory metals.

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17,579 of 1957 (824,805). TEXACO DEVELOPMENT CORPORATION. Simultaneous reduction of a reducible metal oxide and production of carbon monoxide and hydrogen.

19,612 of 1957 (824,216). BRITISH OXYGEN CO., LTD. Refining of lead.

NEW BOOKS, PAMPHLETS, ETC.

☛ **Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.**

Geochemistry and Mineralogy of the Colorado Plateau Uranium Ores. U.S. Geol. Survey Professional Paper 320. Compiled by R. M. GARRELS and E. S. LARSEN. Paper covers, 236 pages, illustrated. Price $2.00. Washington : Superintendent of Documents.

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Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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